PUBLIC WORKS

Devoted to the interests of the engineers and technical officials of the cities, counties and states

DECEMBER, 1939

A. PRESCOTT FOLWELL, Editor — VOL. 70. NO. 12 — W. A. HARDENBERGH, Asso. Editor

Contents

The Index for the year 1939 will be sent to subscribers on request.

TIMEWASTERS

Welcome; and Thanks:

With extreme pleasure we welcome back to our fold John A. Bevan, who has been submerged in Connecticut for the past few years. Mr. Bevan is welcomed with this extreme pleasure, not only because his father is one of our old friends, but also (and especially) because when he writes he usually contributes a couple of good problems. Such good problems being scarcer than turkey teeth, Mr. Bevan stands very high in the esteem of this Bureau of Brainteasing.

We take pleasure in acknowledging briefly, our enjoyment and thanks, for the letters from Mr. Eaton, who says he always loses home arguments, but inclines to believe that breakfast would be ready in 90 seconds; and Edgar Smith who, most appropriately, worked out the train problem on the back of a California "ham-and-eggs" ballot (the late-lamented), and says the telegraph poles are 146′ 8″ apart. These answers refer to November issue problems.

Thanks Again, Mr. Bevan:

1. A man got a check cashed. The teller in cashing the check got the dollars and cents transposed. The man spent $3.50 on his way home, but when he got home his wife found that he had twice as much money as the check called for. For how much was the check drawn?

2. A business executive desires to wear a clean shirt to the office every day and to church on Sunday. His laundry is collected at noon Monday and returned at noon Thursday. What is the minimum number of shirts he must have?

W. A. H.

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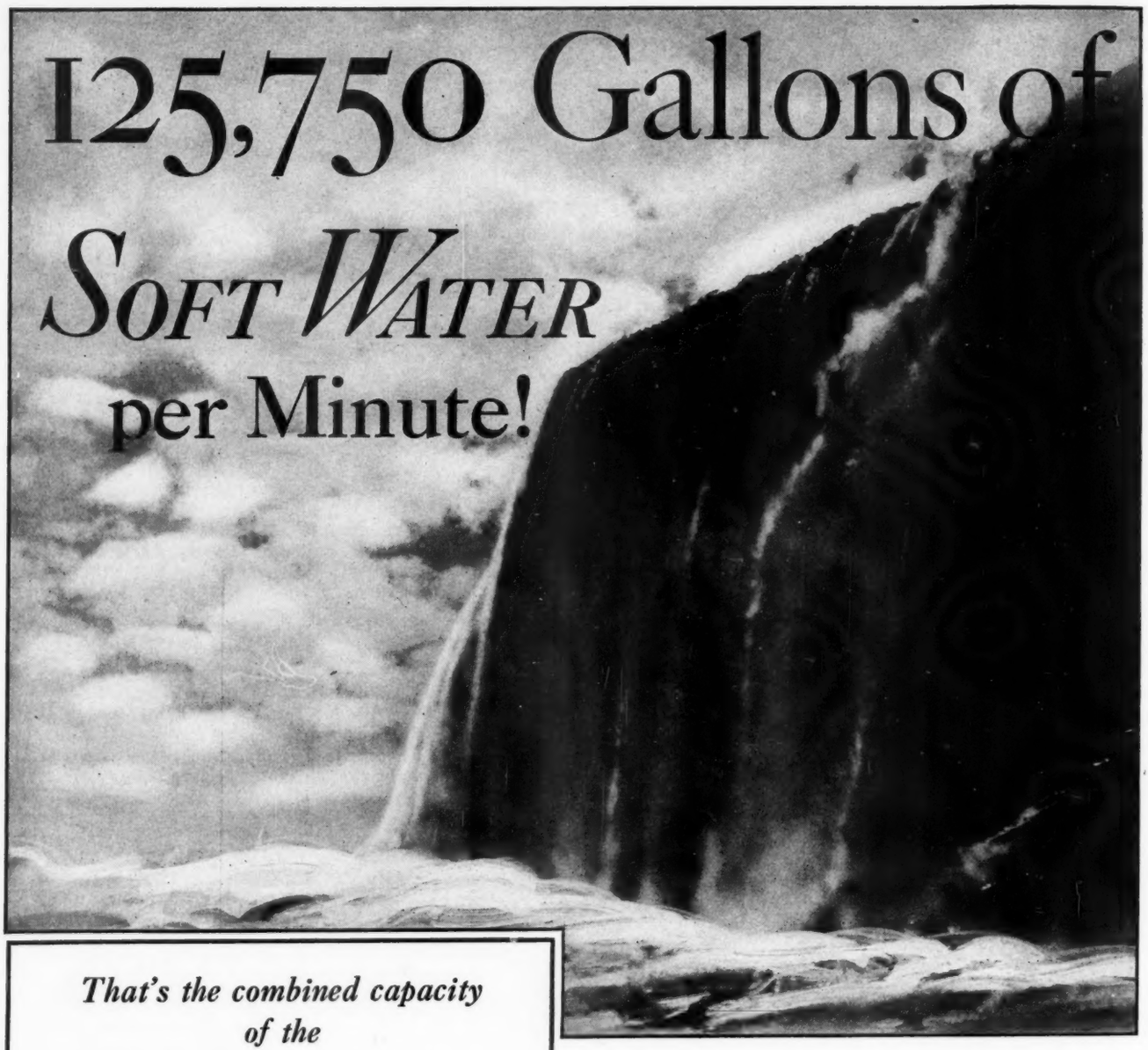

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WATER CONDITIONING *Headquarters*

When you need special information—consult the *classified* READER'S SERVICE DEPT., pages 56 to 58.

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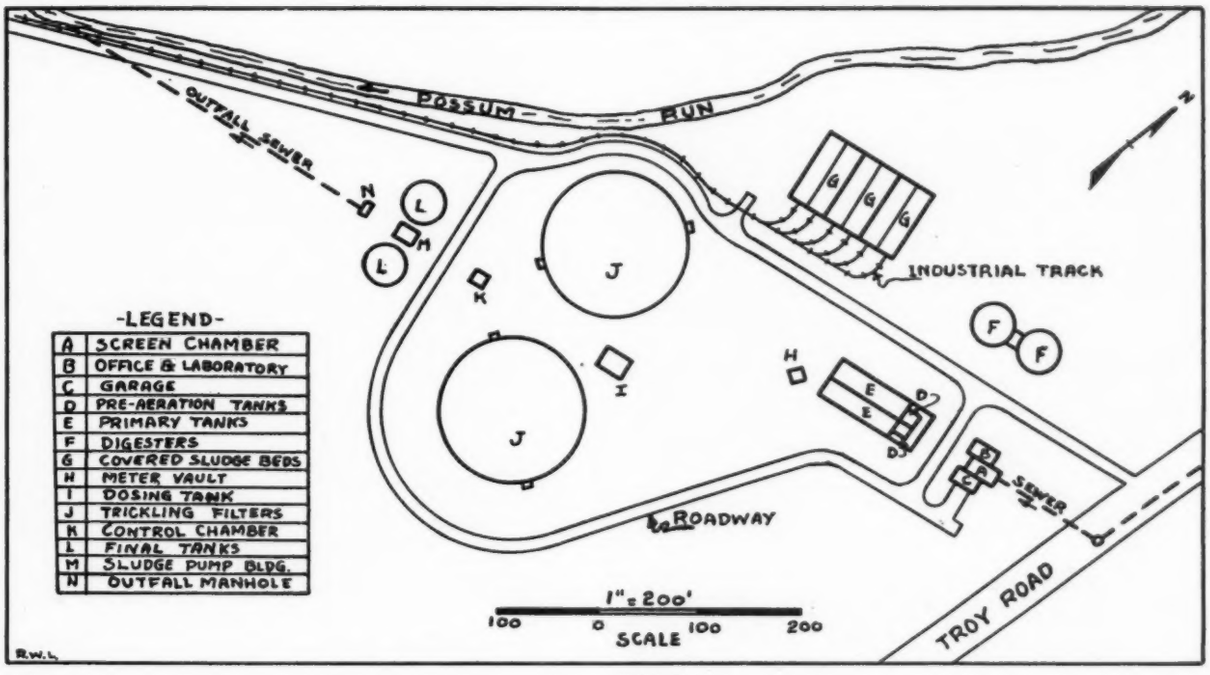


PLAN

Plan of Bellefontaine, O., Treatment Works

Grease Flotation Features New Sewage Treatment Plant at Bellefontaine, Ohio

By FLOYD G. BROWNE

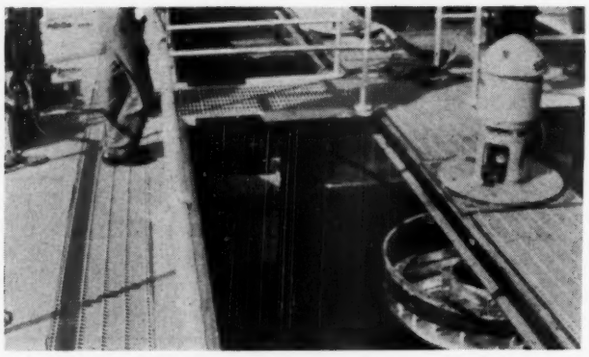
Consulting Engineer

THE original Bellefontaine sewage treatment plant, built in 1912, consisted of a bar screen, two septic tanks, four tank filters and open sludge drying beds. It was designed for 6,000 persons, a flow of 600,000 gallons per day, and cost about $35,000, not including the site of 21.72 acres.

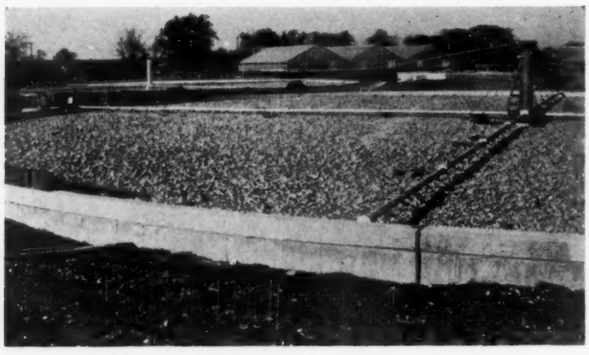
In 1932, a report and general plan for sewage treatment was prepared, in which it was recommended that a new treatment works be constructed, consisting of main control building, a mechanically raked bar screen, two primary settling tanks, two sludge digesters, glass covered sludge drying beds, two trickling filters, two final settling tanks, final tank pump building, together with the necessary pipe lines, conduits, control chambers and chlorination.

In 1933, a portion of these improvements were constructed, costing approximately $15,625; but, due to conditions prevailing at that time because of the depression, additional construction work was deferred. However, it became apparent in 1938 that the proposed treatment works must be completed and a PWA application was filed, bonds were voted, and construction work started late in 1938. The project was constructed under three contracts: Contract 1 was a demolition contract, the work consisting of the removal of existing structures and clearing the site for new construction; bid, $5,871.10. Contract 2 provided for the construction of the treatment works; bid, $170,-692.58. Contract 3, for laboratory apparatus and equipment; bid, $1,277.64. Some of the more important design features are presented herewith.

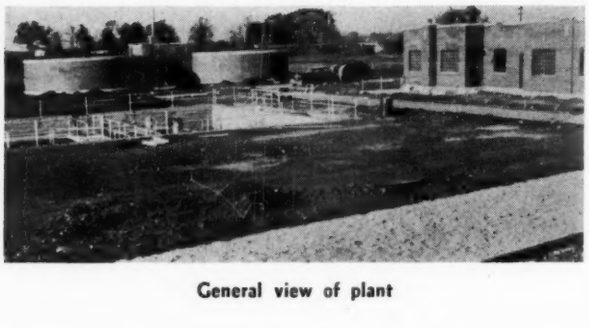
The population of the city in 1930 was 9,543; it was



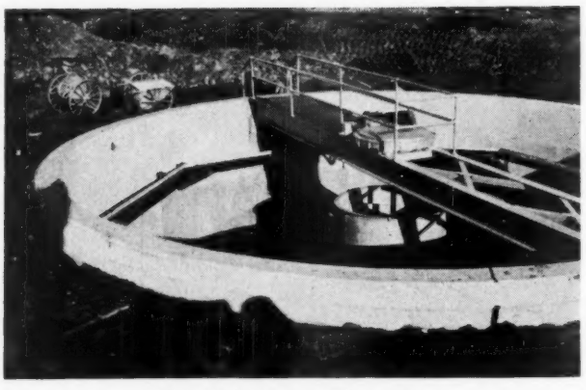
Preaeration and grease flotation tanks



The trickling filters



General view of plant



One of the final settling tanks

estimated that the present population is 10,000, of which 9,000 are connected to the sanitary sewer system, and the plant was designed for 12,500 persons. Actual flow measurements made over an extended period having given an average dry-weather flow of 145 gallons per capita per day, with a maximum flow of approximately twice that amount, the treatment works was designed for a normal dry-weather flow of 1.815 million gallons per day and a maximum of 3.6. A maximum storm water flow of 6 mgd can be taken through the primary settling tanks for partial treatment.

The new plant consists of screens and screenings triturator, grease flotation tanks, primary settling tanks, trickling filters, final settling tanks, chlorinators; sludge digestion tanks, and covered sludge beds.

The sewage on entering the plant passes through a by-pass chamber where flows in excess of any predetermined amount may automatically be by-passed to the creek. Then it passes through a Dorrco mechanically operated screen, the screenings being ground by a No. 2 Chain Belt triturator and discharged to the raw sewage. The screen chamber also is provided with by-pass weirs and control gates.

There are two pre-aeration and grease flotation tanks, each having a capacity of 8,300 gallons and a detention period of 6.6 minutes at the average rate of flow of 1.815 mgd, and each provided with a scum channel which discharges to a nearby raw sludge well. Aeration is accomplished by American Well Works down-draft aerators of a special design for this service. At present the raw sewage is chlorinated, so that in effect the action of grease coagulation and flotation is similar to aero-chlorination described in recent literature. At the time of writing this report these units have been in operation about two months and have demonstrated their ability to remove a very large percentage of the grease and at the same time flocculate raw sewage, with the result that the primary settling tank efficiency in removing suspended solids and B.O.D. is considerably greater than that normally obtained by plain sedimentation.

There are two primary settling tanks, each 66 ft. 6 in. long by 19 ft. wide by 8 ft. average side water depth, having a surface settling rate of 720 gallons per square foot per 24 hours, cleaned with Link-Belt scraper mechanism and equipped with multiple weirs. Sludge is removed by gravity from each hopper to the sludge well through a sludge draw-off valve that is adjustable to secure any desired rate of flow. The primary tank effluent is measured by a Venturi meter equipped with a chronoflow recording mechanism located in the main control building.

There are two trickling filters 150 ft. in diameter with an average depth of filter media of 7 ft., equipped with Dorrco reaction-type 4-arm distributors and a dosing tank of the conventional type. Each filter can be flooded independently. The filtering medium is broken limestone of 2″ to 3½″ size, of which 95 to 100% passes through a 3½″ opening, 0 to 10% through a 2″ opening, 0 to 2% through a 1½″ and 0 to 1% through a 1″.

There are two circular final settling tanks 35 ft. diameter and 7 ft. side water depth, equipped with Dorrco Type A clarifiers. They are provided with multiple octagonal weirs which will give an overflow rate of approximately 4700 gallons per lineal foot of weir per 24 hrs. at the average rate of flow. The average surface settling rate is 940 gallons per square foot per 24 hrs.

Between the two final settling tanks is a pumping station equipped with two vertical centrifugal sludge pumps for returning the sludge to the raw sewage (which will also be used for dewatering the tanks for cleaning), and containing a drainage well to col-

Grease flotation unit by American Well Works

lect all surface water that cannot be discharged into the stream by gravity. The building enclosing these is approximately 15 ft. square with a brick and tile superstructure, which also houses a Wallace & Tiernan chlorinator equipped with a split feed device and rotometers by which either filter effluent or final tank effluent may be sterilized.

Sludge is digesed in two circular tanks, each 35 ft. in diameter with a side water depth of 18½ ft., having a combined capacity of 37,500 cu. ft., or approximately 3 cu. ft. per capita. Each is provided with a PFT floating cover and gas control equipment. The exposed portions of each digester are insulated with a 4″ air space and an 8″ brick veneer wall in place of the usual earth embankment.

Between the two digesters and a component part of the structure, there is located the digester control room, in the basement of which are two sludge pumps which will remove all raw sludge and scum from the sludge well at the primary settling tanks to the digesters; and on the ground floor level of which there is located a hot water heating boiler, gas control apparatus, control piping, etc. The supernatant from the digesters discharges to the raw sewage conduit ahead of the preaeration units.

The digested sludge is dried on six beds with a total area of 9,000 sq. ft. enclosed with a Lord & Burnham glass-over provided with inside and outside ventilators and roof vents. The glass-over is of galvanized iron construction and consists of three ridge and furrow structures each 75 ft. long by 40 ft. wide. The dried sludge is removed by hand-propelled industrial cars of 18 cu. ft. capacity on trackage of 24″ gauge, either to a storage area or to sludge unloading equipment. The latter consists of structural steel framework and overhead track on which is mounted a Louden high-speed lifting unit; the bodies of the industrial cars being provided with lugs to which this unit can be attached and thus the car be elevated so that a truck can be backed under it and the car dumped by hand into the truck.

The main control building consists of three bays, the center one being the screen chamber, the one on the north the office and laboratory, and the bay on the south the garage and workshop. It is constructed of brick and concrete, with cut stone for exterior trim and ceramic glazed brick for the interior trim. It is equipped with a gas-fired steam heating plant, and also houses the electrical control equipment. The office and laboratory are fitted with furniture and equipment, and the laboratory will be completely equipped with all the necessary laboratory apparatus, tools and supplies.

The grounds of the sewage treatment works will be suitably graded and landscaped. Macadam roads and concrete sidewalks will be constructed for accessibility to the various units, and a portion of the site will be enclosed by a cyclone fence.

The work was under the immediate supervision of F. M. Baxley, Chief Engineer of Utilities, who, in addition to being in charge of the treatment works, manages and operates the municipal light plant, municipal water plant, and the municipal gas plant. Design, plans, specifications and general supervision of construction was furnished by Floyd G. Browne and Associates of Marion, Ohio. Roy N. Newell is in immediate charge of construction as Resident Engineer, and the Bellefontaine Development Company of Bellefontaine constructed the work under Contracts 1 and 2.

A V plow on a rural road

Snow Removal and Ice Prevention Methods and Equipment

By F. C. SIEBER

Highway Commissioner, Shawano, Wis.

FOR snow removal and ice prevention and removal, Shawano County, Wisconsin, uses the following equipment:

10—1½-ton trucks equipped with one-way plows.
6—3- to 4-ton four-wheel-drive trucks, with V-plows and wings.
1—5-ton four-wheel-drive truck, with V-plow and wings.
3—10-ton four-wheel-drive trucks, with V-plows and wings.
5—7½-ton four-wheel-drive trucks, with V-plows and wings.
4—60 H.P. tractors, crawler type, with V-plows and wings.
6—15 H.P. motor graders.
4—62 H.P. motor graders.
5—auxiliary motors equipped with a 110-volt generator supplying electricity for lights and power for an oil pump operating the hydraulic lifts on the plow and wings.

These motors are now being used on the five 7½-ton trucks and each truck has, in addition to the regular lighting equipment, 4 white and 2 red flood lights. Equipping the trucks with these motors, we reduce the horsepower of the truck motor from 200 to 150, and have also increased the operating efficiency of the truck. Thus we have good light and much faster operating of the plow and wings.

The above equipment is ample for taking care of any ordinary snow fall. On some occasions another piece or two of equipment would help to open the roads more quickly and might prevent some criticism of the highway department for not opening the roads sooner.

Care of Equipment.—In the fall season after summer maintenance and construction work is about done, all equipment is brought into the shop and thoroughly overhauled. Worn parts are replaced or repaired, each piece of equipment painted and prepared for snow plowing or other use. During the winter and early spring months, motor graders are overhauled, painted and prepared for spring work. When snow plowing is over, plows are overhauled, painted and stored in a building, all ready for the next season. This keeps the equipment in good running order at all times, increases the efficiency and life thereof. Ample storage room for the equipment is a profitable investment.

Worn Out and Obsolete Equipment.—Each piece of equipment is credited with the time it is in use at a regular rental charge. Gasoline, oil, repairs, overhauling, and depreciation are charged against the rental credit. The balance of the rental credit, after charges have been deducted, is sufficient to replace the worn-

out piece of equipment, at the original cost, and create a fund for the purchase of more modern machinery.

Idle equipment is an expense and it is therefore important to purchase equipment that can be used at all times, and not for either snow removal only or summer maintenance only.

Procedure in Snow and Ice Control

We patrol and maintain 198 miles of Federal and State highways, 270 miles of County trunks, and 1158 miles of Town roads for snow removal only. Federal and State highways receive first attention, then County trunks and then town roads.

Federal, State and County trunks are regular routine work. For snow plowing town roads, each town chairman notifies the department whenever he wants a snow plow and then each town is served in rotation of orders as they are received.

For light snow fall and keeping the highways clear of snow, the 1½-ton trucks are used. As the depth of the snow increases and the drifts pile up, the heavier trucks are put into service. When the banks of snow begin to pile up on the side of the road, the tractors are put into service to push the snow back, at least to the edge of the shoulder. Pushing the snow to the edge of the shoulder is of importance, so that when the snow melts in the spirng, the water will have a chance to drain into the ditch, thereby saving shoulder washouts.

Ice prevention and removal are big problems. We are having fairly good success by using motor graders to keep concrete and blacktop road beds free from snow. If ice should form from slush, we use a 6 ft. blade on the grader and scrape the ice down. We use calcium chloride mixed with sand on hills, intersections and other hazardous places.

It is our opinion that a solution of calcium chloride and water sprinkled on a blacktop road bed will prevent ice from forming. The pores and crevices in the pavement will fill up with the solution, thereby preventing the ice from forming, or at least if it should freeze, the ice will be soft and easy to remove with motor graders.

Calcium chloride may damage concrete, but does not affect a tar pavement. This has been proven on hills where a mixture of sand and calcium chloride has been used on concrete. The concrete top scaled and a seal coat of tar and pea gravel was put on. This seal coat was not affected by the calcium chloride. A seal coat of tar and pea gravel on concrete roads would therefore be a great advantage in eliminating the hazard of ice on highways.

Benefits of Snow Removal and Ice Prevention

Snow removal from highways prevents the gravel and dirt surface from being washed away by water in the spring when the snow melts.

It is of great value to the farmer, giving him the opportunity of bringing in his product when he has ample time and the market price is at its best. In the dairy sections, the milk can be delivered to the producers of milk products and the consumers of milk.

Mail delivery to the rural districts keeps the farmer in touch with the outside world, daily.

Open roads mean better fire protection. The purchase of fire trucks by townships is just beginning and this should bring about a big saving from damage by fire in rural districts.

Doctors can make more calls to the rural districts, and the sick can be taken to the hospital within a short time. Hospitalization has increased considerably in recent years and to some extent due to the fact that the roads are open in winter as well as in summer. No doubt some lives have been saved and a lot of suffering eliminated.

Open roads help to stabilize and increase business. If highways were closed, the public would put in provisions enough to carry them through the snow period. With the highways open, provisions are bought as needed and more frequent visits to the stores bring purchases of other commodities—clothing, furniture and etc. Bakery products are being delivered daily in the rural districts. A large portion of merchandise is now transported by truck. This means door-to-door service and saves the retail merchant considerable by not having to carry a large supply on hand.

The above mentioned items are just a few of the numerous ways in which the public is benefitted by open roads in winter. That the benefits are by far greater than the cost of opening the roads, there is no doubt.

Difficult Problems in Snow Removal

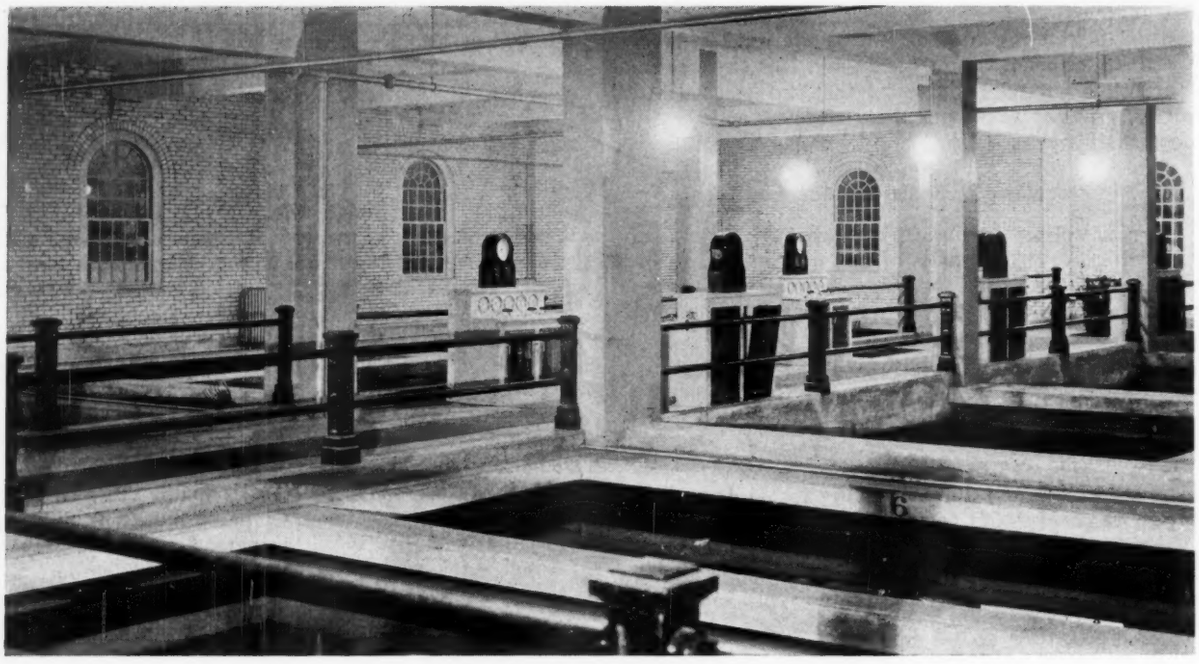
Mail boxes too close to the road bed.

Fences that can be pushed over by hand.

Emergency calls that are not urgent.

Last but not least, to have all roads open within 24 hours after a snow storm or better still, right after the last snow flake has fallen.

An "International" truck and one-way blade plow removing snow



View of interior of Cambridge plant

Filtration Plant VISITORS

Water works superintendents find that public appreciation of their plants is proportional to public information about them. One superintendent tells below one of the methods by which he disseminates such information.

By FRED E. SMITH

Chemist, Water Department, Cambridge, Mass.

THE Cambridge, Massachusetts, water purification plant, the largest in the State, is visited annually by many classes and groups of students, being within convenient distance for visiting groups from the colleges, schools, and hospitals located in Cambridge and several other nearby communities.

Students who come to the plant by appointment in organized groups may be classified in three divisions. First, those from colleges, consisting of students of bacteriology, chemistry, and those enrolled in civil engineering departments, and graduate students in sanitary and public health engineering, and classes from medical schools.

Second, visitors from schools. These are of many different ages, from both the public schools of Cambridge and of many neighboring communities, and from private schools and junior and senior high schools. Organizations such the the Boy Scouts and Girl Scouts also bring groups to the plant.

The third class of visitors consists of student nurses who are in training in the hospitals of Cambridge and other communities—usually first year nurses. Methods of water purification are taught in their courses in sanitation, and the nurses are given an opportunity to inspect the filtration plant in order to supplement the text-book lessons.

It is obvious that a different method of lecture and plant demonstration must be used with each of these classes in explaining the processes of water purification. The purpose of this article is to describe the methods used at the Cambridge plant, some of which may prove to be useful to other chemists of filtration plants who are obliged to budget considerable time for the purpose of explaining water purification processes to groups of visitors. It is recognized that water purification plants differ in many characteristics—size, personnel, coagulants, and mixing methods are only a few of them—and the program of demonstration employed by each must be fitted to its particular features. However, the general procedure to be described will be applicable to most mechanical filtration plants.

The Cambridge plant is of the rapid-sand or mechanical type. The water supply is from impounded sources. Alum is used as the coagulant, and lime and chlorine are used for corrective treatment and disinfection. Normal plant production is 15 mgd. There are 16 filters, each of 1.4 mgd. capacity, with conventional filter appurtenances. A well-equipped laboratory serves for the necessary chemical analyses, bacteriological examinations, and physical tests which control the purification processes.

Appointments for groups of visitors at the filtration plant are made preferably in the afternoon. There are several reasons for this arrangement. Most of the routine laboratory work is performed in the morning; minor repair jobs in the plant, should any be scheduled for the day of the class visit, should be completed before the arrival of the class; if there should be any

delay in starting plant operation in the morning, this would be of no consequence to an afternoon class.

Upon arrival at the plant the class is received in the office. The chemist gives a short history of the water supply of Cambridge, including the establishment of the plant in 1923 and its enlargement in 1932. A general description of the plant is given, and the purification processes in operation are listed. These are coagulation with alum, sedimentation, filtration, aeration, corrective treatment, and disinfection. Little detail of individual processes is given at this time, but promise is made of more complete discussion as each process is observed. The members of the group are invited to ask questions at any time dealing with any phase of the work.

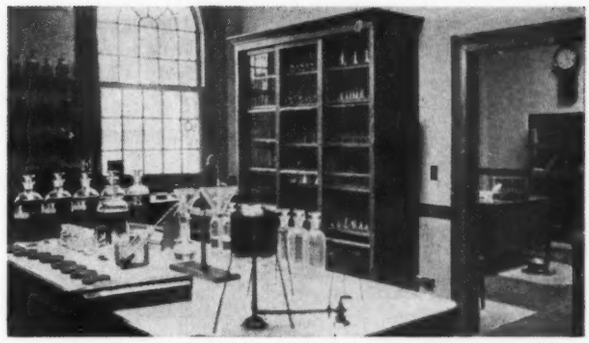
The author prefers to conduct the class through the plant in a manner closely parallel to the course of the water through the several purification processes, believing that this results in a better understanding of the work performed by the entire plant. Weather permitting, the class therefore is conducted first to the influent end of the sedimentation basin, whence can be seen Fresh Pond, one of the supply reservoirs, and Kingsley Park, the area in which the filtration plant is located.

As the water receives the alum dosage in the raw-water main at a point which cannot be inspected conveniently, the sedimentation basin is the first step in the purification processes that can readily be seen. The purpose of the basin is described, its dimensions and capacity are listed, and the method of cleaning is explained.

The class then returns to the filter building and is conducted to the laboratory, where they are shown bottled samples of raw water, settled water, and filtered water, which constitute a permanent exhibit on the laboratory table and have proved to be most useful for demonstration purposes. With these is shown a bottle of sludge illustrating the accumulation of deposited material in the sedimentation basin, and a bottle of distilled water. As effluent colors of 2 or 3 p.p.m. are maintained at this plant, the comparison of the appearance of the filtered water with the distilled water is noted. The exhibit affords visual evidence of the work of the filtration plant in removal of color, dirt, and suspended matter from the raw water.

The bottle of settled water containing alum floc particles may be used in a discussion of coagulation to be given in the laboratory. The extent of discussion of coagulation and other technical phases of water purification will, of course, depend upon the training and interests of the group of visitors. If the class consists of students of sanitary engineering courses, a detailed discussion of coagulation as a rule is invited, of pH and its range in the coagulation of Cambridge water, and the experimental results obtained with other coagulants compared with those of alum treatment. If the group consists of students who have had less technical training, the discussion must be adapted to their knowledge of the subject.

Fred E. Smith



An interior view of the Cambridge laboratory

Bottles containing sludge, rain water, settled water, filtered water and distilled water

While the students are in the laboratory, they are given a description of the analyses and tests necessary for scientific control of the purification processes —determination of color, alkalinity, and other constituents of water—and the reasons for making them. A description of the bacteriological examination of water samples involves a discussion of the presence of coliform organisms in water and their significance. (Obviously, this discussion will be limited by the extent of the students' knowledge of bacteriology.) In this connection, agar and gelatine plates which were removed from the incubators on the day of the class visit make interesting exhibits. The students can be shown the progressive reduction of bacteria effected by the plant, as indicated by the numbers of colonies on petri dishes representing raw, settled, and filtered water samples. *Lactose broth fermentation tubes can be used effectively to demonstrate the elimination of coliform organisms from water. For this purpose a positive raw water tube showing gas formation and several negative effluent tubes may be used. If time permits, the chemist might illustrate one or two of the simpler chemical analyses, such as the determination of alkalinity or residual chlorine. Allowing the students to compare colors of samples in Nessler tubes containing raw and filtered waters is an interesting demonstration of color reduction.

Before leaving the laboratory the class is told in detail about filter construction and operation. This discussion is best given in the laboratory rather than on the filter operating floor where the attention of the group is likely to be distracted and the speaker is heard less easily. Filter dimensions and capacities are listed, and the practice of filter washing is described.

Another exhibit in the laboratory is a model which

Model section of filter

illustrates the construction details of the Wheeler filter bottom. A concrete block 2 feet long and 1 foot square contains two inverted pyramids and a section of a lateral underdrain connected with the apex of the pyramids with bronze throat tubes. A wooden frame with a glass front extends above the concrete base in which are 10″ of gravel and a few inches of sand. This model aids greatly in enabling students to obtain a clear understanding of filter construction. The sand, gravel, and the cement balls within the pyramid can readily be seen, and the purpose of the filter underdrain system is understood by the students.

The group then is conducted to the filter operating floor. A filter has been removed from service and drained preparatory to washing while the students were in the laboratory. Before the wash is started, the purpose of the filter control table is described, and the information recorded on the filter chart is explained to the group. The accumulation of alum floc on the surface of the sand is indicated, and the purpose of the wash water troughs is explained. The wash rate is given, and the relation between this figure and water temperature is explained.

When the filter washing operation has been completed, the group passes on to the chemical storage room in which the alum machines are located. Here are described the functions of the solution hoppers and of the ejector which forces the alum solution through the feed line to the point of application in the raw water main. The operation of this dry-feed equipment is contrasted with that of the discarded solution-feed apparatus.

The aerator is next on the schedule. The type of aerator used at the Cambridge plant consists of riffle plates over which the filtered water flows, which presents an attractive picture to all groups, irrespective of age or training. The purpose of aeration is explained, and the improvement in the quality of the water as a result of aeration is described.

The group next visits the lime machine and the chlorinator. The purpose of corrective treatment and disinfection of the filtered water is explained, and the operation of the equipment is described. Following this discussion, questions are invited upon any phase of the purification processes, and the plant demonstration is ended. The elapsed time will be about one hour for a college class which desires a technical discussion of filtration plant operation.

The above is a general outline only of the subjects covered. Each group is given as thorough an explanation of each process as it is able to understand. With younger school students the demonstration must be less technical; for girls and boys from the lower school grades the plant demonstration will consist of a simple description of the water samples in the laboratory exhibit and a view of filter washing and the aerator. Groups of nurses can be given some technical explanation of purification processes and a detailed description of laboratory procedures, including bacteriological examinations.

The details of these explanations will of course differ as the plants themselves differ. However, several years of experience in conducting organized groups through the Cambridge filtration plant have developed the outlined schedule, and it is the author's belief that the students obtain a clear understanding of the purification processes by this method of plant demonstration. When it is successful, the students will usually ask many intelligent questions pertaining to the work being done. Some classes desire dimensions of filters and basins, others are interested only in general information about the filtration plant. Student engineers are interested in the mechanical features of the plant, such as the alum equipment and details of filter design. Students of chemistry ask many questions about laboratory control of water purification.

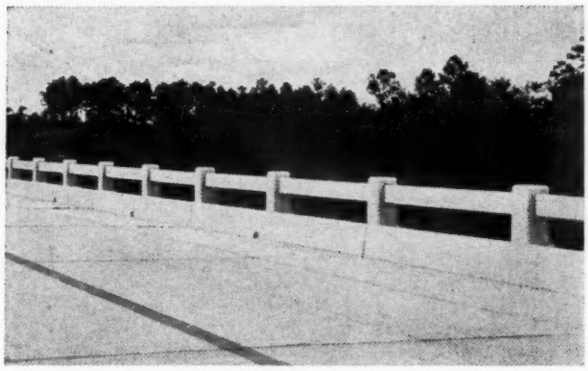
In addition to organized groups, the Cambridge filtration plant is visited by many individuals. Students in sanitary engineering courses often desire to examine blue-prints of plant structural details. A medical school student may desire considerable information about water purification as a part of a city health survey. Students in nearby educational institutions have prepared theses dealing with several of the purification processes. Visitors interested in sanitary and public health engineering from other cities and states of this country and from foreign lands have recorded their names in the visitors' register. For these individual visitors no definite schedule can be arranged. Each is assisted in obtaining the desired information which might apply to the entire plant or to some single phase of the work.

The reception of visitors and the demonstration of plant operation are an important part of the resident chemist's duties. The good will that results from an earnest effort by filtration plant personnel to be of assistance to visitors is distinctly worth while.

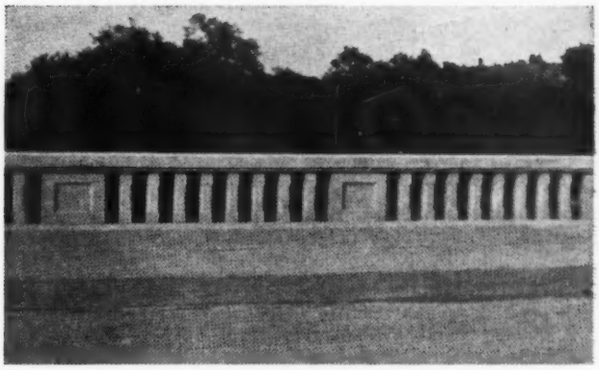
Cofferdamming an Underpass

In building an underpass under the Great Northern Railway near Casselton, North Dakota, the lowered highway is carried below the water table for over 500 ft. of its length, and it is necessary to drain the subsoil under the road to a sump, from which the water is pumped by two electrically driven, automatically operating non-clogging pumps of 1000 gpm capacity. A system of 6″ drains, laid in herringbone pattern in the gravel base, lead to the sump.

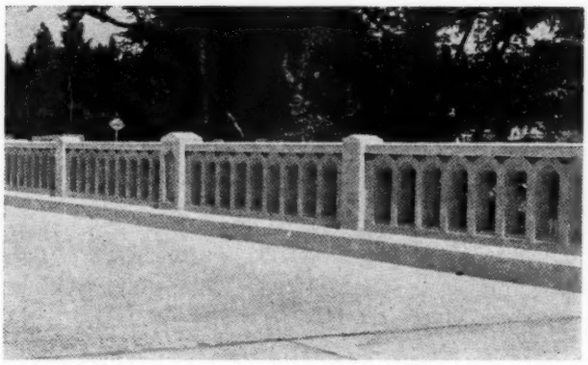
To limit the amount of water to be pumped, the entire length of road below water level is enclosed in a cofferdam which is 770 ft. long, 48 ft. wide at each end, and 80 ft. wide at the center so as to include the abutment walls. The cofferdam is made of creosoted (6 lb. of creosote per cu. ft. by empty-cell process) Douglas fir tongue-and-groove 4 x 12 in. plank 18 ft. long, with a continuous line of 4 x 6 waling fastened by galvanized bolts on each side of the line of sheet piling, at the top, which is 6 ft. above the lowest point of the grade and is covered by the side slopes where above pavement level; which level is about 3 ft. above the piling where it crosses under the pavement at the ends.



Strong, simple, inexpensive, beautiful and low enough to see over. New handrail of the Georgia Highway Department embodying the essential features of good design.



A modern handrail designed by the Tennessee Department of Highways on U.S. 41, the road which the Middle West follows to Florida.



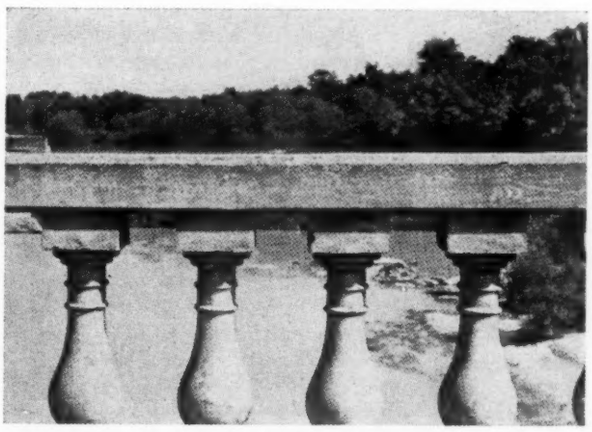
A handrail on a Virginia Department of Highways' bridge.

A modern Mississippi handrail on a bridge with a sidewalk.

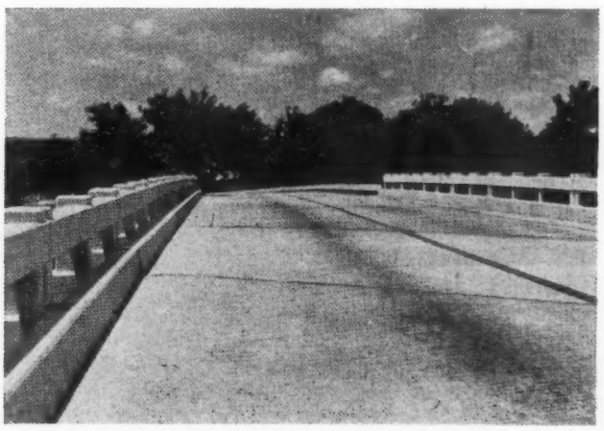
Bridge Handrails—GOOD and BAD DESIGN

RECENT years have witnessed great improvement in handrails. A decade or two ago they were massive and superlatively ugly. The modern handrail is low enough to permit the passing motorist to get a glimpse of the stream flowing beneath —they no longer need to be high to keep fractious horses from hurdling them. The sturdy hub-rail is a substitute for height, keeping motor vehicles in the path. The rest of the handrail is largely ornamental, serving as a guide to traffic or as an actual handrail for the few pedestrians.

The accompanying photographs (for which we are indebted to "Concrete Highways and Public Improvements") show handrails that have been used by various highway departments in southern states. Experience indicates that anything that protrudes beyond the rail may be sideswiped and chipped by passing trucks, and projections above the rail cause an annoying flicker in the vision of the passing motorist.



A "motorist's-eye view" of a handrail taken through an automobile window shows how a too-high rail completely blots out a view of a stream and mill.



A South Carolina handrail, beautiful, simple, inexpensive; no posts protrude to be sideswiped by passing trucks. A newer design places the posts below the rail top.

Toluene Method of Determining Soil Moisture Content

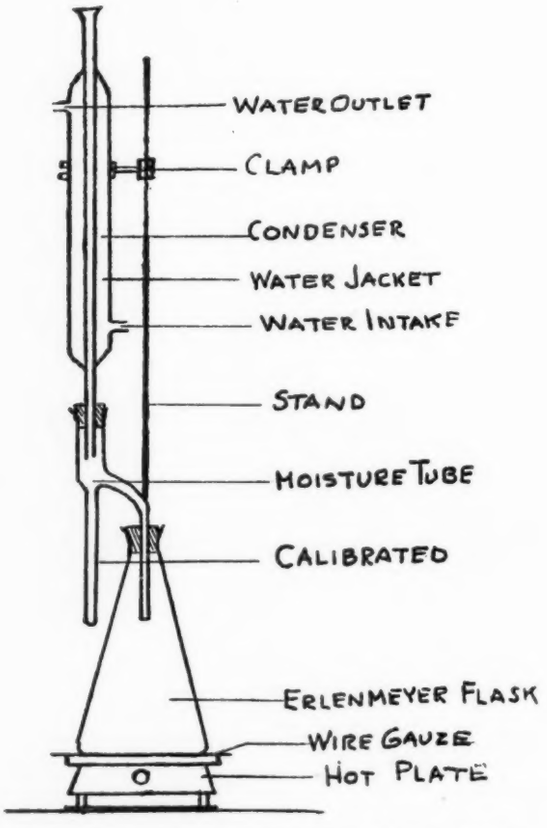
By JOHN C. HORVATH

A short-cut method permits results to be obtained in about one-fourth the usual time without sacrifice in accuracy.

John C. Horvath

CONTROL of soil moisture is necessary to secure maximum density of soils under compaction, as in earth dams, embankments, fills, etc. The principles of soil moisture control are well known and most modern earth structures are being built in accordance with these principles. (For a discussion of the factors, see Public Works for June, 1935, "Soil Technology in Earth Dam Construction.")

In the control of soil moisture, field tests are necessary, and in order to facilitate control, fairly quick results are desirable. In the construction of the Wild Creek Dam of the Bethlehem Municipal Water Authority, Bethlehem, Pa., a new and quicker method of determination has been developed, using toluene. Equipment, materials and procedure for this method of testing are as follows:



Sketch of apparatus used in the toluene method for determining moisture in soils

Equipment necessary:

Moisture tube.
Condenser (Liebig).
Erlenmeyer flask.
Hot plate (Electric).
Analytical balance.
Rubber tubing.
Stoppers, clamps and wire gauze.

Material:

Toluene or related groups (benzene) as moisture free as possible. Benzene is much cheaper.

Procedure:

Place a sample of soil (25 gms.) into the erlenmeyer flask, to this add the toluene (benzene) (50 c.c.), place on hot plate (note sketch) under a condenser and heat. The toluene and moisture will vaporize and then condense on contacting the water jacketed condenser. The condensation mixture will flow down into the moisture tube. Because water is heavier than toluene the moisture will drop to the bottom of the tube and toluene will seperate to the top and flow back to the flask. Continue to heat for approximately one hour until there is no longer any moisture coming over into your moisture tube; this can be noted by the drops of moisture dropping through the toluene into the bottom of the tube. The moisture tube is calibrated in cubic centimeter and therefore the per cent moisture can be computed directly in the dry weight basis.

Example:

Weight of soil	25	gms.
Reading on tube	3.6	c.c.
	21.4	

$$\frac{3.6}{21.4} \times 100 = 16.8\% \text{ moisture}$$

This method is used in conjunction with regular gravimetric method and with the Proctor Plasticity Apparatus.

The Editor's Page

War and Sanitary Engineering

With war so widespread these days, it is interesting to consider the part that engineers play in the everyday practice of this undesirable science. They are little concerned with front line combat; their most important work is in preserving the health of the combatant units and in expediting the movement of vital and necessary supplies and equipment.

Thirty years ago sanitary engineers had little place in war plans, but now they are an essential. In addition to planning, building and operating water and sewage treatment and waste disposal plants, eliminating flies and mosquitoes, and combating rats, lice and bedbugs, in and around army establishments, cantonments, hospitals, etc., they have to consider many other jobs. Modern technique for protection of big cities against bombing includes movement of the population into rural areas; and in these rural or semi-urban areas, added provision for water supply and waste disposal may be necessary. Safe water supplies and even protection against other sources of disease must be provided not only in cantonments and the cities adjacent to them, but over a range greatly increased by the mobility the automobile has provided. Internment camps for captured enemy soldiers, and even for enemy civilians, must be provided, and these, too, must have adequate sanitary protection. (From Norway comes the interesting note that the German sailors forming the prize crew of the City of Flint were interned in an old fortress where safe water is provided by a modern water system which includes American-made filtration plant equipment.)

This list of jobs for the sanitary engineer does not pretend to be complete. Some time ago we discussed the possibility of contamination of water supplies by aerial bombs containing poisonous gases, and the engineer's job in handling this problem. Mechanization of the army offers a still more difficult job in providing safe water for the troops in the field—a job that has not yet been given enough consideration. There is plenty of work for these engineers to do.

Service Life of Cast Iron Pipe

Basing their conclusions on an exhaustive study of the complete 72-year records of the mains of the Springfield, Mass., water works system, Newsom and Aldrich estimate the average life of cast iron mains to be 140 to 200 years; with some reaching an age of double these figures. (See the "Water Works Digest" in this issue.) Of course, if and when any pipes fail to deliver the necessary amount of water, they should be replaced by larger ones; but even then can usually be returned to service elsewhere.

The most common cause of demand for increased carrying capacity is increase in the population of the city in question; although use of water for air conditioning and for industrial purposes are important factors in some cities. But increase in population is falling off rapidly and is predicted to be approaching the vanishing point. It would seem, therefore, as though we should in the future obtain a service life for most cast iron mains well in excess of 100 years.

But there is one deterrent to this in some cases—the capacity of the mains may decrease because of tuberculation or other growths or deposits on the interior of the pipe. These may even terminate the service life in ten to twenty years—a fifth to a tenth of what should be obtained. In other words, cities where pipes are subject to such constriction of bore area can, by preventing it, increase five or ten fold the value of their mains, which constitutes 50 to 80 per cent of the value of the entire water works.

Such being the case, it would seem to be most economical and otherwise desirable to utilize the best possible protection for new pipe (or use pipe not subject to corrosion); and also to discontinue passing through old mains, that can not now be so protected, water that causes such rapid decrease in their service life. If corrosive water must be used, it would be economical to secure complete protection of the pipe even if such protection cost more than the pipe itself. And to conserve the capacity of pipe not adequately protected, it would be economical to pay annually for water treatment up to the annual depreciation due to corrosion—5% to 10% of the cost of the pipe system, in the case assumed above.

Medicated Water Supplies

Water works men have been told time and again that too much fluorine in water produces mottled teeth. A few weeks ago they were told at a Pittsburgh meeting of the A.P.H.A. that too little fluorine causes tooth decay, and that the non-objectionable range is very small.

To the suggestion that the fluorine content of public water supplies be adjusted to this range, Harry E. Jordan says: "Between mottled enamel from too much fluorine and dental caries from too little, lies a field for much study by dietitians, physiological chemists, dentists and doctors so as to discover just how the diet and drink intake of the individual contributes to the making and maintenance of good tooth structure.

"Several years ago water works men were advised by some investigators that they could help reduce goiter in certain cities by adding iodine. A few cities tried it, only to learn that the medical profession felt that greater benefits would be attained by direct treatment for those who clearly suffered from iodine deficiency.

"Water works engineers need the evidence of wide research along with dental and medical approval before they are led into mass medication through public water supplies. Their task is the production of safe and palatable water supplies, adequate in amount constantly served at reasonable cost. They must await widespread professional support before expanding the scope of their activities."

To this opinion we fully subscribe.

1,000,000-gal. Elevated tank

New Water Filtration Plant

By CAPT. ROBERT B. JOHNSTON, QMC,
Constructing Quartermaster

THE reservation of Fort Benning, Georgia, is located about nine miles south of the City of Columbus and contains approximately 96,000 acres. The Post area is located on high ground above the banks of the Upatio creek, and above the flood waters of the Chattahoochee river. The original water supply system was completed in 1920-1921 and consisted of a raw water pumping station delivering water from the Upatio creek to a rapid-sand, gravity filtration plant having a capacity of 1,500,000 gallons per day. As the water treatment plant was considered more or less temporary, the sedimentation basins, filters, clear water storage and high level storage were all wood-stave tanks. A large part of the distribution mains were also of wood-stave construction.

During the course of years the wooden structures failed and were replaced with concrete units. Wood-stave pipes were replaced with cast iron. The post increased in importance as the Infantry School for the Army. Temporary buildings were replaced with permanent ones, and the garrison was constantly being increased with a resulting gradual increase in water consumption and the need for a larger and more dependable water supply. Although some improvements and additions were made in the existing treatment plant during these years, it was not until 1938 that a thorough investigation of all phases of the water supply problems of Fort Benning was completed by the local authorities in conjunction with the Office of the Quartermaster General, Washington, D. C., at which time it was determined that it would be more economical and desirable to provide a complete modern water filtration plant with all accessories, than attempt to rehabilitate and enlarge the existing plant and maintain satisfactory water service for approximately 10,000 people during the construction period.

Plans and specifications for a new plant having a total capacity of 6,000,000 gallons per day were prepared in the office of The Quartermaster General, Washington, D. C., and construction was started on March 1, 1939. All construction work is being completed under the direction of the Constructing Quartermaster, Fort Benning, Georgia. While the capacity of the plant may appear larger than necessary for the normal population of Fort Benning, yet when consideration is given to increased population, due to summer training camps and under war time conditions, when a total population of 40,000 to 50,00 may be reached, the necessity for this capacity is self evident.

Roof of clear well

The following is a brief description of the component parts of the water supply system:

Water enters a concrete intake on Upatio creek through bar screens and thence through two 20″ cast iron, cement lined pipes, to the raw water pumping station. The concrete intake on supporting piling is constructed on the creek bank a short distance above a low diversion dam which insures submergence of the inlet gates to the intake at all times. The intake is designed with blow-off valves to insure easy removal of sand and other sediment which may be deposited in the bottom of the intake chamber.

The raw water pumping station consists of a circular concrete pit, the bottom of which is below the level of the creek bed. In view of the fact that the Upatio creek has a flood range of 40 ft. or more, it was necessary to design this pumping station to prevent flotation and locate it so that it would be accessible in the event of high flood waters. Three horizontal electric motor driven centrifugal pumps are installed in the bottom of the concrete pit with suction lines connected directly to the 20″ lines extending from the intake. These pumps have the following capacities: one 1400 g.p.m.; one 2100 g.p.m.; one 2800 g.p.m. The superstructure houses electrical control equipment such as motor starters, ventilating equipment, monorail with hoist, a gasoline engine driven electric generator set to provide emergency power in case of interruption in the main source of electric power, for the operation of the 1400 g.p.m pump,

For Fort Benning, Georgia, Designed For 6MGAD

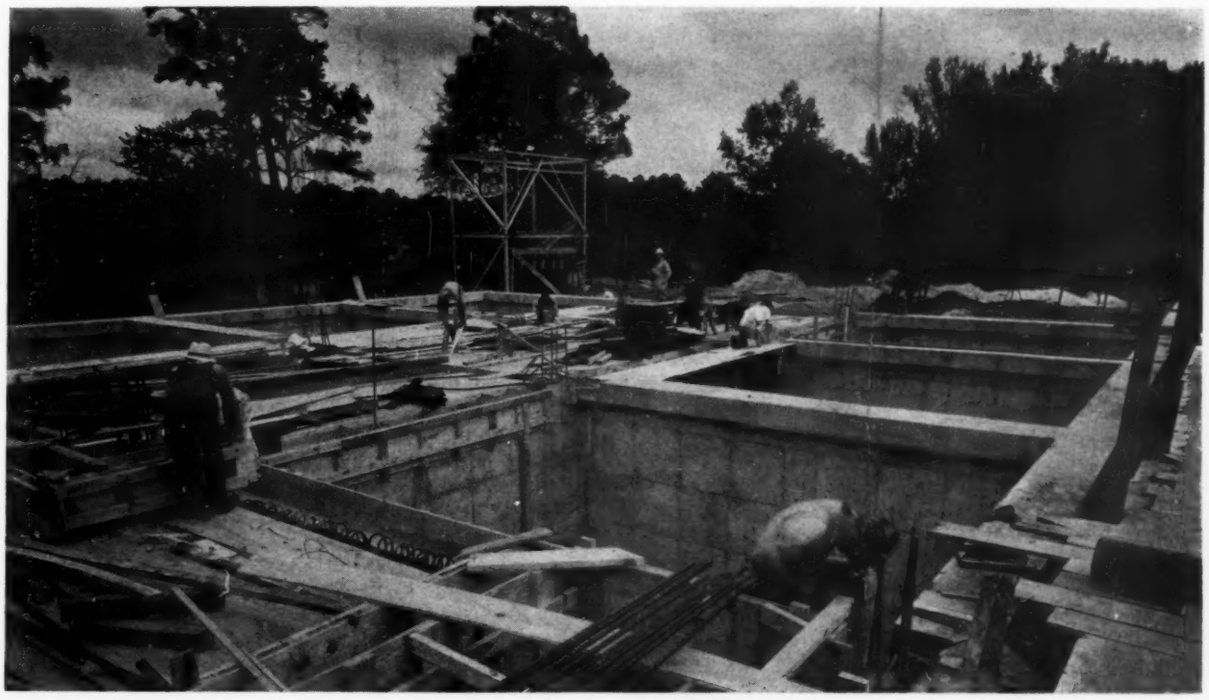
Increasing importance of Fort Benning as Army training center a factor in construction of new plant. Plans prepared by Quartermaster General. Details of design.

for lighting the filtration plant, and also to operate small motors such as chemical feeders, mixers, etc., in the filtration plant.

The raw water pumps discharge through a 20″ cast iron main to the raw water receiving well inside of the filtration plant proper, at which point the necessary chemicals for coagulation are added. The water from the Upatio creek is a soft, surface water containing varying amounts of turbidity and color. The chemicals used for coagulation are alum, and lime which is added to the raw water at times in order to supply the necessary alkalinity for complete reaction with the required alum dosage for color and turbidity removal. From the raw water receiving well the water passes to two mechanical mixers, electric motor driven, each equipped with a vertical shaft, which is provided with stirring arms. The mixers are arranged to operate either in series or parallel. The electric motors have variable speed control devices so that the rate of mixing may be changed to suit varying conditions. A retention period of 15 minutes is provided when the plant is operating at a six m.g.d. rate.

The water then flows to the sedimentation basin, which is divided into two sections, has an effective depth of 10 ft. after allowing for sludge storage, and provides four hours theoretical retention period when operating at the six m.g.d. rate. The floor of the sedimentation basin slopes to drains so that deposited material may be easily removed while being agitated by high pressure hose streams.

The effluent from the sedimentation basin is conducted to the pipe gallery of the filtration plant through a 30″ cast iron pipe. The filters consist of six 1 m.g.d. units, each being 18′x20′x10.5′ deep and designed to operate at a two gallon per square foot per minute rate. Each filter is equipped with an operating table for the control of the hydraulically operated control valves located in the pipe gallery and is also provided with loss-of-head and back-wash gauges. Wash troughs are constructed of reinforced concrete. Filters are backwashed



Pumping station wells and foundation

Construction work under way

with water from a steel wash-water tank located in the rear of the filtration plant and kept filled by an automatically controlled 250 g.p.m. pump. Provision is also made for emergency back-wash of the filters by means of high pressure from the high service discharge lines. The underdrain system of the filters consists of perforated brass laterals. Due to the fact that low temperatures are not encountered at Fort Benning, the filters are located in the open and only the operating floor between the filters is housed to provide protection for the operating tables, etc. The tops of the filters, outside of the building, are approximately 7 ft. above grade, and access to this area is provided by doors opening from the operating floor to walkways which extend around the filters.

The filter effluent line discharges into an inspection well which is lined with white tile and provided with submerged light to indicate the quality of water being passed by the filters. As the water leaves this inspection well, lime is added for pH adjustment to reduce corrosive properties of the filtered water, and chlorine for sterilizing purposes. The filtered water then enters the clear-water storage reservoir, which is provided with curtain walls to prevent short circuiting and insure proper retention period for reaction with the lime and chlorine before the water is delivered to the distribution system. The clear well has a storage capacity when filled of 500,000 gallons and is provided with a reinforced concrete slab cover. This cover is approximately 4 ft. below finished grade and entrance to the clear well is through hinged sidewalk doors installed over manholes at the surface of the ground.

Water is drawn by the high-service pumps from the clear-water storage reservoir and delivered to the post distribution system through parallel lines of 14″ and 16″ pipe. The 14″ pipe was part of the original water supply system and was used for delivery of raw water from the original pumping station to the site of the old filtration plant. Under the new arrangement this line will be used as a treated water line. The high service pumps consist of three units as follows: one 1400 g.p.m., one 2100 g.p.m., and one 2800 g.p.m. The 1400 g.p.m. pump is a combination driven unit with an electric motor at one end and a gasoline engine at the other, so that in case of electric power failure it will still be possible to deliver water to the post.

The post distribution system consists of approximately 116,363 feet of cast iron mains of sizes varying from 6″ to 16″, inclusive. Included in the distribution system is a 1,000,000 gallon steel standpipe located at the end of the distribution system nearest the filtration plant and at the other end a recently constructed 1,000,000 gallon elevated steel water tank. The high water levels of these two storage tanks are at approximately the same elevation and overflow is prevented by automatically controlled altitude valves. With these two tanks floating on the distribution system, uniform pressures throughout the post are assured. They also provide storage for supply of water in case of peak demands and emergencies such as fires, etc.

All of the pumps—both raw and high service—are manually controlled from the central master control panel located on the operating floor of the filtration plant. In addition to this control panel, there are also provided raw water and high service meters, respectively, each having indicating, recording, and registering devices; a recording pressure gauge to indicate pressure in the discharge mains of the high-service pumps; a clear-water storage depth gauge; and a wash-water tank depth gauge. With these instruments located at a convenient point on the operating floor it is possible for the operator to readily determine which units are in operation, the amount of water being pumped and other operating data.

The main building of the filtration plant is two stories high in addition to the basement floor, and is constructed with reinforced concrete frame, brick walls, steel windows and doors, and with a flat built-up roof. On the basement floor are located the high-service pumps, wash-water pump, electric control room and pipe gallery. On the first or grade floor are located the chemical feed room, the filter operating room, office, laboratory, lockers, and toilet room. On the second floor is located the chemical storage. A freight elevator runs from the basement floor to the chemical storage room with openings at grade and all floors of the building. No heating is provided for the building except for the office and for the laboratory, where electrical unit heaters of the fan circulating type are provided. Hot water for the laboratory is supplied by an electric storage type heater.

The following contracting firms were employed on this work:

Central Contracting Company, Dallas, Texas, general contractors for building and appurtenances.

Roberts Filter Manufacturing Company, Darby, Pa., contractor for filter equipment.

The Worthington Pump and Machinery Company, Harrison, N. J., contractor for the high-service and wash-water pumps.

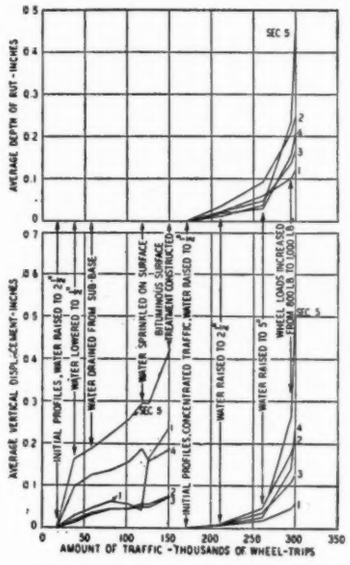
Burford, Hall & Smith, Atlanta, Georgia, representatives of the De Laval Pump Company, contractor for the raw-water pumps.

R. D. Cole Company, Newnan, Georgia, contractor for the steel wash-water tank. This company was also contractor for the one million gallon elevated steel tank.

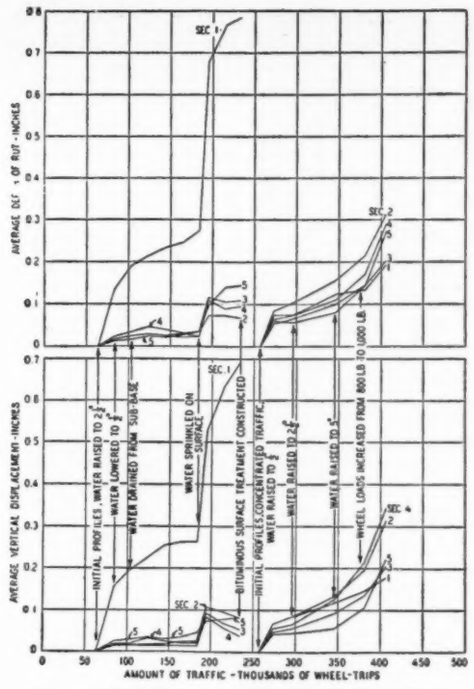
It is expected that this water filtration plant with appurtenances will be completed and placed in operation about January 1, 1940, and will provide a continuous, satisfactory and dependable water supply for Fort Benning.

Concrete Paving Mileage in the Nations

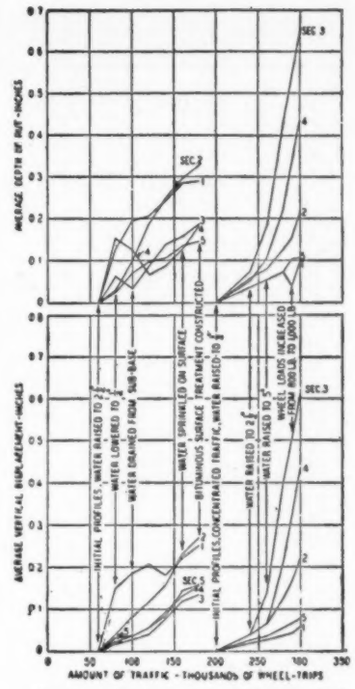
The yardage of concrete roads in the United States is more than ten times as great as in all the rest of the world combined. According to "Road Abstracts," the square yardage in the principal countries is as follows: United States, 1,751,799,000; Germany (exclusive of Austria), 44,257,000; United Kingdom, 40,923,000; Denmark, 13,331,000; Belgium, 8,759,000; France, 4,828,000; Italy, 4,769,000; Holland, 3,344,000; Hungary, 2,996,000; Sweden, 1,944,000; Austria, 1.350,000; Switzerland, 1,043,000; Poland, 909,000; Norway, 399,000.



Surface displacements of sections of track 1 at various stages of the test.



Surface displacements of sections of track 2 at various stages of the test.



Surface displacements of sections of track 3 at various stages of the test.

Calcium Chloride and Sodium Chloride as Admixtures With Road Materials

Water-retentive chemicals used as an admixture with non-plastic road materials are beneficial in reducing raveling and in preparing bases for bituminous surfaces.

THE Division of Tests, Public Roads Administration, has for several years been conducting laboratory and field studies of various types of base-course materials. The results of some of these have already been published. The latest report on this subject (November 1939) deals with the effect of using water-retentive chemicals—calcium chloride and sodium chloride—as admixtures with nonplastic road building materials; also, incidentally, the behavior of such materials without such chemicals. The 14-page report describes the tests in detail. Below is a brief abstract of the description and the conclusions drawn.

Mixtures of granular aggregate and clay binder that form highly stable road surfaces may become unstable as bases when covered with a waterproof surfacing.

Nonplastic granular materials, having gradings within definitely established limits, provide stable base courses for relatively thin bituminous surface treatments, although when subjected to traffic prior to surface treatment they may be loose and dusty in dry weather and the loss of surface metal may be excessive. Moisture films, however, serve to bind such nonplastic aggregates into a coherent road surface, and certain chemicals, used either as admixtures or surface applications, aid materially in maintaining these moisture films under suitable climatic conditions.

In making the tests herein referred to, four circular tracks were built, each divided into five sections. In tracks 1, 2 and 3 the materials used were gravel, sand, pulverized silica and clay, mixed in different proportions. In track 4, crusher-run limestone, blast furnace slag, and granite were used; limestone in section 1, granite in section 2, blast-furnace slag in section 3, 90% granite and 10% slag in section 4, and 90% granite and 10% limestone in section 5. The gradings are shown in the table.

Calcium chloride was used as an admixture in track 1 and sodium chloride in track 2, adding 2 pounds per square yard as a solution along with the water. Track 3 was tested without a chemical admixture. Track 4 was tested first without chemical treatment and then with a surface application of calcium chloride.

The surfaces were compacted by running loaded pneumatic-tired wheels over the road until no further subsidence was noted. The wheels were then run continuously, moving in and out so as to distribute the wear, until raveling was noticed. The surface was then sprinkled and the test continued. The bituminous surface was then applied and compacted, and a test run with concentrated traffic. In applying the bituminous

Gradings and soil constants of materials used in study of water-retentive chemicals

	Track No. 1, section—Using calcium chloride					Track No. 2, section—Using sodium chloride					Track No. 3, section—No chemical used					Track No. 4, section—Surface application				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Grading:	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Passing 1-inch sieve	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Passing ¾-inch sieve	98	98	95	96	97	98	96	97	97	98	96	92	97	93	97	100	100	100	100	100
Passing No. 4 sieve	75	80	66	69	63	76	73	67	62	58	79	67	56	61	59	98	94	65	98	95
Passing No. 10 sieve	62	69	57	59	52	65	64	56	50	46	66	59	48	50	46	55	63	35	64	56
Passing No. 40 sieve	40	46	37	35	31	40	43	35	30	26	45	41	33	30	29	25	43	19	41	37
Passing No. 200 sieve	23	24	18	12	9	23	26	19	12	7	25	22	16	12	9	12	16	5	16	14
Passing 0.005 mm	7	6	5	4	4	8	8	6	5	5	11	5	4	3	3	3	3	1	3	2
Dust ratio [1]	58	52	49	34	29	58	60	54	40	27	56	54	48	40	31	48	37	26	39	38
Tests on material passing No. 40 sieve:																				
Liquid limit	17	17	18	16	18	18	17	16	15	16	17	14	14	13	10	14	15	27	25	25
Plasticity index	2	0	0	0	0	3	2	2	0	0	2	0	0	0	0	2	0	0	0	0

[1] Dust ratio $= 100 \left[\frac{\text{percentage passing No. 200 sieve}}{\text{percentage passing No. 40 sieve}} \right]$

surface, the track was trimmed smooth, a prime of 0.3 gal. per sq. yd. of light tar was applied, and then 0.4 gal. of hot application bituminous material covered with 50 lb. of ¾ in. stone.

In making the test on Track 1, compacting was completed with 18,200 wheel trips, except Sec. 1, which required 38,200 trips. Sec. 5 began to ravel slightly at about 20,000 trips and Sec. 4 at about 100,000. Secs. 2 and 3 remained good throughout the test. Sec. 1 became slightly unstable after sprinkling, and Sec. 4 and 5 were good during sprinkling and raveled later. All were good after the bituminous surfacing up to the end of the test—298,500 wheel-trips—except that Secs. 4 and 5 became slightly unstable after 261,200 trips. The wheel loads were increased from 800 to 1,000 lbs. at 295,000 trips.

Track 2 was compacted with 64,000 wheel trips, except that Sec. 1 required more than 100,000 trips. The other four sections showed slight raveling between 104,000 and 184,000 trips. They were then sprinkled, when Sec. 1 became slightly unstable but the others returned to good condition. After 234,300 trips the bituminous surface was applied and tested with concentrated traffic. All remained in good condition up to 347,000, when all but Sec. 1 began to become slightly unstable, but Sec. 1 continued in good condition until the end of the test with 407,000 trips.

In Track 3 (no chemicals) compacting was completed with 60,000 trips on Secs. 3, 4 and 5; with 80,000 on Sec. 2, but Sec. 1 did not get in good condition until sprinkled, after 160,000 trips. Secs. 2 and 3 began to ravel after 80,000, and Secs. 4 and 5 after 100,000. After sprinkling, all remained good for another 20,500 trips, when the bituminous treatment was applied. After this, Secs. 1 and 2 remained good to the end of the test—300,000 trips. Sec. 3 was good through 240,000, and Secs. 4 and 5 though 260,000, when these three sections became slightly unstable.

"In general, the behavior of the five materials without chemical admixture was conspicuously different from that of the corresponding sections of tracks 1 and 2 prior to the application of the surface treatment. Section 1 failed to compact well, as did the same section in the two previous tracks, showing considerable movement throughout the 60,000 wheel-trips of compacting traffic. The surface became dry and dusty, indicating that evaporation was proceeding at a faster rate than the water could be brought up through the material by capillarity. No such behavior was observed in tracks 1 and 2 where water-retentive chemicals were used as admixtures."

Track 4 was tested for 242,600 trips without chemicals. Secs. 1 and 3 remained good for 182,600 trips, when they began to ravel. The other sections began raveling from the first. After applying calcium chloride, Sec. 1, 2 and 3 were in good condition, Secs. 1 and 3 throughout the test and Sec. 2 for only about 6,000 trips. Secs. 4 and 5 continued unstable until the bituminous surface was applied, after 366,000 trips, and became unstable again after 434,300. Secs. 4 and 5, in fact, were unstable throughout the whole 534,300 wheel trips except for about 68,000 just after applying the bituminous surface, although there was no dusting or raveling after the calcium chloride was applied.

Some of the conclusions from the test are as follows:

The tests with distributed traffic prior to surface treatment on track 3 without chemical admixure showed that these materials all raveled badly unless they were kept damp by capillary moisture from the ground water table or by water sprinkled on the surface.

Considered as surface courses, the materials used in tracks 1, 2 and 3 would be subject to raveling and dusting in dry locations without chemical treatment.

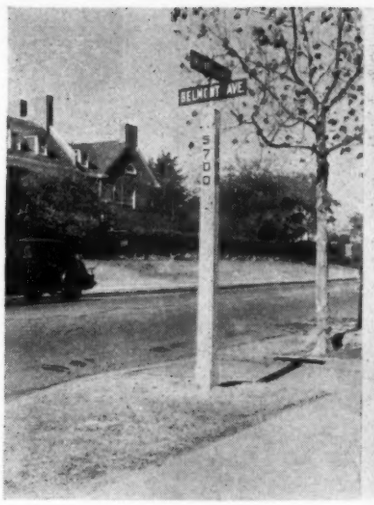
Chemical treatments proved beneficial in the construction of bases for bituminous surfaces. The admixture of calcium chloride expedited compaction. Both calcium chloride and sodium chloride reduced raveling while the base courses were carrying traffic prior to construction of the bituminous wearing course. These results were retained under conditions of high relative humidity.

The presence of 15 to 25 percent of material passing the No. 200 sieve is necessary to prevent the loss of a large part of the water-retentive chemicals when water falls on the surface and percolates through the mixture.

A surface application of calcium chloride was effective in reducing dusting and preventing raveling on all five sections in track 4. However, the moisture held near the surface of sections 2, 4 and 5 by the calcium chloride promoted the formation of corrugations to a detrimental extent.

County Engineer as Public Officer, Not Employee

In an action by a county engineer for a balance of $50 a month for ten months from a salary fixed by the county commissioners at $200 a month, it appeared that the board had reduced the amount because of a subsequent state statute reducing the salary of such county engineers to $150 per month. The plaintiff's duties were outlined and prescribed by statute, leaving only to the county the matters of appointment and the fixing of length of service and salary. The Kansas Supreme Court (Miller vs. Board of Commissioners of Ottawa County, 71 F. (2d.) 875) held that the plaintiff was a "public officer" rather than an "employee" with ministerial duties, and that his salary could be reduced by subsequent legislation without impairing the obligation of a contract as prohibited by the Federal Constitution, the written appointment not being a contract though it might be so denominated therein. Judgment for the defendant was therefore affirmed.



Left: Concrete street sign post in Dallas

Right: Corrugated metal forms for meter boxes

Precast Concrete Units Serve Many Uses

How Dallas, Texas, by its regular city forces, makes concrete posts for street signs, meter boxes, traffic buttons and culvert slabs. About 10,000 posts are being made, and about 2,000 meter boxes a year.

PRECAST concrete posts for street signs, boxes for water meters, traffic buttons and slabs to make culverts that carry water across unpaved streets where othewrise a valley gutter would be necessary, are precast at central yards and installed throughout the city of Dallas, Texas.

Several years ago street signs on posts were removed and street names were painted on the face of concrete curbs at intersections. Time dimmed this paint and, still worse, tires rubbed against them and made the names illegible. The Department of Public Works had to spend considerable money cleaning these and repainting the names, so it was decided to go back to signs on posts, and to make the posts both good looking and serviceable.

Street Name Posts

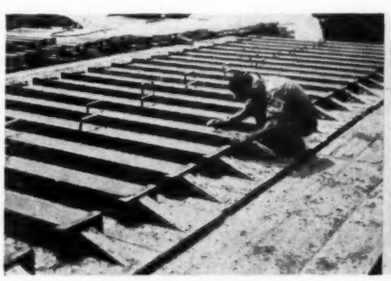
The posts are 10 ft. long, 5½ in. square at the bottom and 4½ in. at the top, with beveled corners. Reinforcement consists of a ¼-in. round rod in each corner of the post. A 1½ x ⅜-in. steel plate, 18½ in. long, to which the signs later are bolted, is embedded in the top of the post for a distance of 5½ in. The upper 7½ in. of the plate is given a one-quarter twist, so that the signs will stand at right angles to one another.

Proportions are designed to produce a concrete with a compressive strength of at least 3,500 lb. per sq. in. at 28 days. The coarse aggregate is washed gravel having a maximum size of ¾ in. and the fine aggregate is sand. Proportions are commonly 1:2:2 and strengths have been well above the design minimum.

Materials, equipment and engineering supervision for the sign posts are furnished by the city except for the regular allowance per man hour which the WPA makes for materials. The WPA supplies the labor for casting and erecting the posts. Equipment consists of a shed in which much of the work is done, a mixer, wood forms, a one-ton truck and small tools. Work is done in two shifts and 52 men are employed.

About 30 posts are turned out per day, at a cost to the city of $1.94 per post. The porcelain enamel signs cost $0.40 each and four are used per post, since two carrying the same street name must be bolted together, back-to-back, so that the sign can be read from either direction. The first project called for 4,000 posts. A second project will bring the total to 10,000 posts. Cost of the posts installed has been around $7 each.

The most commonly used precast box culvert is made of identical top and bottom slabs, each 2 feet 8 in. wide and 4 in. thick, and two identical side slabs, each 1 ft. wide and 4 in. thick. Lengths are varied to provide staggered joints and to allow an opening for inlets from side streets but do not exceed 4 ft. This provides a waterway 2 ft. wide and 1 ft. high. The bottom or floor slab is not always continuous, but is to be put in only at joints, as a foundation. The slabs are reinforced with ½-in. bars



Casting box culvert slabs

Concrete meter boxes

Traffic buttons on Dallas street

running transversely and ⅜-in. bars longitudinally.

A particular advantage of the precast culvert is that, when a street is paved and other drainage is provided so that the culvert is no longer needed, it can be taken up and used over again at some other street intersection.

Culvert costs average about $1.50 per foot in place. When this type of precast culvert was first constructed, the city bought the right to use a patented form which had been developed locally. This form has been improved upon from time to time by the city forces.

Meter Boxes

The concrete meter boxes are cast and installed by the water department. One type is used for ⅝, ¾, and 1-in. meters. Another type of box is used for meters between 1 and 3 in. in size, and for still larger meters the concrete box is cast in place, as it is too large and heavy to be conveniently handled as a precast unit.

Most of the precast meter boxes are 17 in. high and 18 in. in diameter at the bottom with corrugated walls from 1½ to 2 in. thick. The box has no bottom. A standard metal rim casting and cover forms the top. A heavier ring and cover is used where the box is set in a driveway or a similar location where it will be subjected to heavy loads. When the box is installed, holes are broken in the bottom edge of the wall so that the box can be set over the water pipe.

Concrete for the meter boxes is proportioned 1:2:4 and a gravel of 1-in. maximum size is used for coarse aggregate. Forms are corrugated metal. About 2,000 boxes are used per year. They are cast and stored in a central yard until used.

Concrete has cost about $0.45 per box, the light weight metal ring costs about $0.45 and the light weight cover costs $0.90.

Meter boxes of this type have been in use in Dallas for over 30 years and have been generally satisfactory. They are used over again if they have to be moved from their original location.

Traffic Buttons

The city also casts a concrete button, to be used in defining traffic lanes at dangerous intersections. An old style enameled wash basin is used for a form and a pipe is put in the center of the button through which a bolt is run to fasten the button to the street. These buttons have been costing the city $0.23 each and hundreds of them have been used to make the city's streets safer.

Only the street sign posts have been a WPA project. The other units are cast intermittently by small crews of regular city forces.

Using Sludge Gas as Vehicle Fuel

Middlesex County, England, has decided to place orders for a $35,000 plant for compressing sludge gas for use in operating vehicles. It is estimated that the cost of compressing the gas would be 6 cts for the equivalent of a gallon of gasoline. The drainage department of the county uses more than 200 (British) gallons a week, costing about $3,500 a year, and it is proposed to equip its own vehicles with gas cylinders at first; then extend the use to other county vehicles, followed by sale to the public. The Mogden treatment plant produces over 150,000 cu. ft. of methane a day, equivalent to 700 gal. of gasoline, worth $95,000 a year.

Sludge gas containing 70% methane was said to have advantages over coal gas and be particularly suitable for standard gasoline engines on acocunt of its anti-knock properties and gives 40% more energy than the same volume of coal gas.

The plant would consist of two 6-stage compressors of 100 cfm capacity each, and four storage cylinders with a working pressure of 5,000 lb. per sq. in. The cylinders for using the gas have a capacity of 1.75 cu. ft. at 3,000 lb. pressure, equivalent in energy to nearly 2 gal. of gasoline. The gas is discharged through reducing valves into a mixing chamber, and thence into the ordinary standard carburetor of the vehicle.

Thin Concrete Pavements on Good Subgrades

Experiments have been carried out in Sweden by the State Road Institute to discover the effect of reducing the usual thickness, cement content and amount of reinforcement of concrete surfacings on good subgrade. The vibration method and the Holter method of placing were both tried on experimental roads laid down in different parts of the country. Test specimens were taken during construction and beams were sawn from the finished surfacing. Loading tests on surfacings have been carried out. The following results were obtained:

Experimental roads. (a) A thickness of 8 cm (3 in.) is apparently too little; in some cases a 10-cm. (4-in.) reinforced surfacing has proved sufficient. (b) The cement content must be at least 275 kg./m.^{3} (463 lb/cu. yd.) to guarantee sufficient abrasion strength. (c) A reinforcement of 1.5 kg./m.^{2} (2.75 lb./sq. yd.) is sufficient to diminish cracking and hold the edges of cracks together.

Quality of the concrete. (a) Vibrated concrete and Holter concrete with the same cement content appear to have the same strength, modulus of elasticity, and density. (b) Vibrated concrete and Holter concrete must have cement content of 275 kg./m.^{3} (463 lb./cu. yd.) if the same strength as in ordinary concrete surfacing is desired, i.e. 40 to 45 kg./cm.^{2} (570 to 640 lb./sq. in.) bending strength after 28 days. (c) For the same strength, vibrated concrete, Holter concrete and normal concrete have apparently the same modulus of elasticity.

Loading tests on surfacings. (a) In corner loading the greatest tensile stress appears in the upper surface along the corner bisector: the distance from corner point to maximum stress decreases with increasing load: for the same load, the harder the subgrade the nearer the corner does maximum stress develop. (b) Corner failing load increased with increasing cement content, the increase being dependent on the hardness of the subgrade: the increase in failing load with increasing thickness was not so rapid as might be expected from theoretical calculations: the bearing power of the subgrade exerted considerable influence. (c) The greatest stress in a slab for a given load occurred when the load was placed at the free edge, the maximum stress was developed directly below the load at the bottom of the slab. (d) The stresses and deflections at transverse and centre joint were as great as at free edge, showing poor degree of efficiency of joint design. (e) A surfacing with a uniform thickness of 10 cm. (4 in.) was not sufficiently strong, even if the subgrade was good. On the basis of these results minimum dimensions of concrete surfacings on a good subgrade have been suggested.

This is a summary from Road Abstracts. The report, which contains 76 pages, has been published by the Institute at Stockholm, Sweden, in Swedish with a summary in English.

Methods and Results of Activated Sludge Treatment of Dairy Wastes

By SYLVAN D. MONTAGNA

Assistant Engineer, Bureau of Engineering, Pennsylvania Department of Health

DAIRY wastes from The H. W. Walker Company of Somerset, Pennsylvania, producers of bottled milk and cream, whole and skimmed milk, cultured buttermilk, butter, ice cream, ice cream mix, bulk cream, skimmed condensed milk, powdered skim milk and cottage cheese have been successfully treated by the activated sludge process.

This plant receives an average of 60,000 pounds of fluid milk daily, of which approximately 90 per cent is processed into dairy products, 8 per cent is bottled and the remaining 2 per cent represents the milk loss. The volume of waste from all processes, including can and bottle washings, equipment and floor washings is 50,000 gallons daily.

The essential units of the activated sludge treatment plant are (1) a lime tank (2) receiving chamber or wet well (3) mixing chamber (4) primary settling basin (5) aeration and final settling basins (6) two conventional-type air blowers and (7) air lift devices.

The essential principles for treatment of milk wastes by activated sludge involve neutralization of lactic acid and precipitation of protein material to form a sludge. Sufficient aeration and recirculation must be provided to decompose the oxygen-demanding substances and to seed the incoming waste. Settling basins are provided to settle out sludge for removal and recirculation.

Method of Operation

An air lift raises the raw waste from the wet well to the mixing chamber, where it is mixed with milk of lime to maintain a pH range between 8 and 9 (approximately 100 parts per million). The lime solution serves to neutralize the lactic acid and precipitate the suspended caseins in the raw waste to form a sludge and to prevent septic conditions in the primary settling basin.

The mixing chamber is 10 ft. square, hopper-type, with vertical sides to a depth of 4 ft. and thereafter with 60° slopes from the horizontal. The maximum depth of this chamber is 11 ft. To this compartment is returned settled sludge from the primary settling tank, and the sludge-waste mixture is constantly agitated by a current of air diffused through a concrete diffusion plate, 2 feet square. The sloping sides prevent the accumulation of undesirable and decomposable matter within the chamber. The capacity of this chamber is 6,000 gallons.

From the mixing chamber the effluent passes over a weir into the primary settling basin, which is approximately the same size and shape as the mixing chamber. An air lift returns part of the settled sludge from the bottom of this basin to the mixing chamber for recirculation. A by-pass line conveys settled sludge to a tank truck for disposal by plowing under. Three hours before the removal of the sludge, the recirculation air lift is turned off to allow the sludge to settle. The amount of sludge removed once daily from this basin is 400 to 500 gallons, containing approximately 50 per cent settleable solids by volume.

The effluent from the primary settling basin flows over a weir to the aeration basin which has a capacity of 60,000 gallons. The aeration basin is a rectangular dual hopper tank with a surface area of 66 feet by 20 feet and a maximum depth of 9½ ft. The retention and aeration period in this basin is about 24 hours.

The lactic acid-forming bacteria in the aeration basin convert the milk sugars to lactic acid, thereby reducing the pH to between 7.6 and 7.8, the most favorable medium for this type of bacteria. A further decomposition of the milk sugars occurs simultaneously to form carbon dioxide and water. Sufficient aeration is maintained to keep the dissolved oxygen above 2 parts per million.

The overflow from the aeration basin passes over a weir into the final settling basin which has 12,000 gallons capacity. The shape of each basin-hopper is the same as that of the mixing chamber. The dimensions of this tank are 20 feet by 10 feet with a maximum depth of 13 feet. Air lifts return the settled sludge from the bottom of each hopper to the aeration tank for recirculation and seeding. About 200,000 gallons per day of sludge are returned, and no sludge is removed from the system at the final settling basin.

The clear effluent from the top of the final settling basin is drawn off by three overflow troughs and passes into a small stream.

Cost of Construction and Operation

The entire cost of installation of equipment and construction of all basins was estimated at $12,000. The costs of operation per day include 50 pounds of hydrated lime, power for a 5 H.P. motor operating the air blower continuously, 2 hours of labor, and the expense of operating a tank truck. These total $3 per day.

Calculations based on the capacity of the air blower, operated by a 5 H.P. motor, 860 R.P.M., show that the quantity of air used for all purposes, namely, mixing, aerating and operating air lifts, is 2.8 cubic feet per gallon of waste treated. The capacity of the blower is 96 cubic feet per minute. The amount of B.O.D. removed daily by 115 K.W.H., the power consumed, is 224 pounds or .51 K.W.H. per pound of B.O.D. removed. During the three years that this plant has been operating, the entire system has been cleaned only two times.

The results of operation, as shown by studies of the Pennsylvania Department of Health over a 3-year period, indicate that the average reduction in B.O.D. was from 545 ppm. to 7.4 ppm, or 98.4%. Total solids were reduced from 797 ppm. to 466 ppm. Population equivalent was reduced, on this basis, from 1400 people to 18. Maximum efficiency of the plant was 99.0%; the lowest efficiency while the plant was operating successfully was 96.0%. Average removal of total solids was 42%. Raw sewage pH varied from 5.2 to 8.2; effluent pH varied from 7.3 to 8.1.

The only other plant of a similar nature is at New Bremen, O., at the White Mountain Creamery Co. Re-

sults from this plant over an 83-day operating period show an average flow of raw waste of 34,100 gpd., pH 7.5; 5-day B.O.D., 1285; total solids 6465. The effluent had an average 5-day B.O.D. of 4.8, representing a reduction of 99.7%; figures on total solids reduction are not available. Raw waste pH varied from 5.9 to 9.5.

Summary and Conclusions

The activated sludge process has been successfully used for the disposal of milk product factory wastes. The major conditions necessary for successful operation are:

(1) Sufficient milk of lime must be used to precipitate and neutralize the suspended caseins and lactic acid in the raw waste, to prevent septic action in the primary settling basin, and to maintain a pH of 7.6 to 7.8 in the aeration basin.

(2) The sludge from the primary settling basin must be recirculated with fresh waste in the mixing chamber to produce a more readily settleable sludge in the primary settling basin.

(3) Before the sludge is removed from the primary settling basin to the tank truck, recirculation to the mixing basin is stopped to allow sufficient time for settling. At this disposal plant three hours has been found to be sufficient time for settling.

(4) Sufficient aeration must be provided to agitate continuously the mixtures in the mixing chamber.

(5) Sufficient aeration must be maintained in the aeration basin to keep the dissolved oxygen above two parts per million to avoid septic conditions.

(6) The sludge in the final settling basin must be recirculated to the aeration basin for the purpose of seeding the effluent from the primary settling basin.

(7) Auxiliary blowers must be provided in case of breakdown or emergency repairs, since the system must be operated continuously to avoid septic action.

(8) The routine tests for the determination of the efficiency of the plant should include 5-day B.O.D., pH, total solids and volatile suspended solids. The B.O.D. determinations are an index of the efficiency of treatment and a measure of the pollution load. pH control is necessary to measure the active alkalinity that must be maintained to insure a favorable medium for bacterial action and precipitation. The total solids and volatile suspended solids determinations are an index to the amount of inorganic and organic matter that is being discharged by the system. Any increase in the amount of volatile suspended matter would give an increase in the B.O.D. value.

This article is an abstract of a paper delivered by Mr. Montagna at the Pennsylvania Sewage Works Association meeting at State College, Pa., last June.

Life Cycle of Trickling Filter Flies

In a discussion before the Georgia Water and Sewage School, G. R. Frith, assistant engineer of the Georgia Dept. of Public Heath, said that the length of the life cycle of the trickling filter fly varies greatly with the temperature. In Georgia, where a temperature between 75° and 85° prevails most of the summer months, the life cycle becomes as short as 7 days. This would seem to necessitate flooding at least once a week if flies are to be controlled by this method; but since sewage plants are built primarily to treat sewage, and flooding temporarily interrupts purifying action of a filter, it should be employed no oftener than is necessary. In fact, it would seem as though, in such warm climates with short life cycles, some other method of control is desirable.

Dry Ice Used for Developing Well at Glendale, Arizona

THE town of Glendale, Ariz., in 1928 put down a 16" well 1001 ft. deep, passing chiefly through heavy clay with some gravel and a cemented stratum of caliche and other conglomerates. The casing was perforated every five feet from the bottom up to the 350 ft. level. Above this there were no perforations, thus excluding the hard water near the surface. When tested, the well yielded 833 to 837 gpm.

The yield had been falling off, even with increased draw-down, and it was decided to repair the pump bowls and clean out the well. In March, 1939, a well driller bailed out all of the mud and sand to the bottom of the casing, and it was decided to endeavor to increase the flow by the use of dry ice.

The dose of dry ice used was arbitrarily set at 500 lb., and four such doses were used. At 6 P.M. ten 50 lb. pieces of dry ice were dropped into the well. In 5 to 10 minutes the well erupted, throwing to a height of 40 to 50 ft. water, mud and some oil that was in the water. This was repeated twice at 3- to 5-minute intervals.

About 20 min. after the well had subsided, another 500 lb. charge of dry ice was dropped in. This caused a great deal of rumbling and, after an interval of an action like boiling, the water was discharged to a height of more than 50 ft., bringing ice with it, which was immediately thrown back into the well. This occurred twice more. The second charge of dry ice caused a discharge of more water and less mud than the first one.

The third 500 lb. dose was applied thirty minutes after the subsidence of the second. For 10 to 15 minutes no action occurred; then there were three separate eruptions, the water being thrown to a height of 30 to 35 ft.; following which the water in the well boiled for a period without other evident action.

Twenty-five minutes after the third discharge, the fourth charge of dry ice was applied. After five minutes of boiling in the well, the water was erupted to a height of 40 to 50 ft. three times at 3-minute intervals, bringing up considerable mud and silt.

Upon lowering the bailer into the well the following day it was found that there was 45 to 50 ft. of clay and silt in the bottom of the well. The standing water level had risen from 81 ft. below the surface to 63 ft. below. Bailing out for four hours removed 26 cu. yd. of clay and sand, which filled about 40 ft. length of an irrigation ditch to a depth of 2 to 5 ft. Although the bailer was lowered four successive times after this, no more material was removed—an abrupt cessation of the flow of material into the well which was notable.

When pumping was renewed, with the water level 140 ft. below the surface and free surface discharge, the rate was 846 gpm (compared to 833 to 837 gpm ten years previous when the pump was first put into operation). Discharging against a surface head of 100 ft. the pump discharged 750 gpm and the water level rose to 120 ft. below the surface; and against a head of 275 ft. the pump discharged 625 gpm and the water rose to 110 ft. below the surface.

Subsequent to this cleaning operation the water level has remained at a depth of 71 ft., showing a slight drop since the time of cleaning. At present the average level of water when the pump is in operation is 125 to 127 ft.

below the surface, or a draw-down of about 56 ft. when the pump is delivering 693 to 700 gpm—a yield of approximately 12 gallons per foot of draw-down.

The above information is from an article by Charles W. Hircock, Superintendent of Water of Glendale, in the Bulletin of the Arizona Water and Sewage Association.

Purchasing for Small Cities

Nearly one-third of the expenditures for current operations of the average municipality are for supplies, materials, equipment and contractual services. Efficiency and economy are obtained by several hundred municipalities by employing specially qualified purchasing agents to exercise authority over all such expenditures. These include only a small number of the smaller communities, mostly those under council-manager form of government. This would seem to be unfortunate. However, those which are unwilling or unable to adopt complete centralization can use some of the controls the public water supply, but also the treatment technique of centralized purchasing or adaptations thereof.

To assist small cities in deciding to what extent they wish to adopt centralized purchasing and in installing a system therefor, Public Administration Service has prepared a manual* discussing the principles and techniques of centralized purchasing or adaptations thereof, and suggesting charter and ordinance provisions for establishing a purchasing office on a sound legal basis.

There seems to be no single or "model" pattern for the organization and administration of a purchasing office. "There are, however," says the pamphlet referred to, "certain basic factors upon which the success of such an office depends. These factors are as follows:

"1. Centralization of authority over purchases.

"2. Employment of competent purchasing personnel.

"3. Development of standards and specifications to assure the quality of goods purchased.

"4. Consolidation of departmental requirements into quantity purchases in order to obtain lower prices.

"5. Stimulation of active competition among bidders.

"6. Inspection and testing of goods delivered to enforce compliance with specifications and terms of orders.

"7. Control over goods in storage.

"8. Control over salvage."

Where the volume of purchases is too small to warrant a full-time purchasing agent, the work can be assigned to some qualified staff officer. If the government is of the council-manager form, this is generally the manager.

If the city can not or does not wish to centralize the purchasing authority, it can designate some one official as purchasing adviser, who will study the requirements and methods of the several departments and suggest improvements in procedures and possibly cooperation in making purchases. Or an interdepartmental purchasing committee can be created to obtain these ends. In time, either may develop into a full-fledged central purchasing agency.

It is estimated that centralized purchasing saves, on the average, from 10 to 15% of the money spent by the city on purchases; therefore it is well worth while to spend this amount in conducting a purchasing agency, for, in addition to the direct saving, such an agency, through expert drafting and enforcement of specifications for the goods purchased, ensures a better quality than generally is obtained otherwise.

*"Purchasing for Small Cities." By Russell Forbes, Com'r of Purchase, City of New York. Public Administration Service, 1313 East 60th St., Chicago, Ill. Price 50 cts.

Weight of loose sawdust for varying moisture content in pounds per bushel										*Water to be added to mix, per bag of cement*	
										1:3½	1:3
10.5										10 gals.	9 gals.
	12.0									9½ "	8½ "
		13.75								9 "	8 "
			15.5							8¼ "	7½ "
				18.0						7 "	6¾ "
					22.0					6 "	5¾ "
						23.8				5¼ "	5 "
							25.0			5 "	4¾ "
								26.0		4¾ "	4½ "
									27.5	4¼ "	4 "
0%	25%	50%	75%	100%	125%	150%	175%	200%	250%	Per cent moisture	

Example:—Average weight of three test samples is 18.0 lbs. In the column at the extreme right in line with the 18.0 you will read 6¾ gallons of water. This is the total amount of water to be added to the 1:3 mix.

Water required per bag of cement; for 1:3½ and 1:3 mix

Cement Sawdust Concrete

CEMENT-SAWDUST concrete is a mixture of Portland cement, sawdust and water in proper proportions. The appearance is much the same as ordinary cement-sand mortar, but the average weight is only about 45 pounds per cubic foot, or about one-third that of ordinary concrete. This light texture has advantages for certain uses where strength is not necessary and where resistance to severe wear is not important.

Compressive strength varies with the proportion of cement used, averaging 300 to 400 pounds per square inch. Cement-sawdust concrete is an insulating agent. The coefficient of thermal conductivity is 0.60 to 0.70, as compared to 0.25 to 0.40 for various commercial insulating materials, 1.00 for wood and 8.00 for ordinary concrete. It is water repellent, easily finished to a smooth surface, relatively resistant to abrasion, resilient, and fire resistant in that it will not support combustion. It can be sawed with an ordinary carpenter's saw, and will hold nails and screws.

A brief note in this magazine some months back elicited a number of inquiries for further information regarding this material. The data in this article are from Circular 217 of the University of New Hampshire Extension Service, which was prepared by Russell R. Skelton, Associate Professor of Civil Engineering. Circular 217 was prepared with especial reference to the use of cement-sawdust concrete in farm structures, such as poultry house and dairy barn floors, but the information it contains is applicable to other uses, provided caution is observed in using this material where it is may be placed under stress. In other words, little is known as to its structural qualities.

Materials.—Sawdust should be that obtained from the main saw, rather coarse in size and not less than one year old. White pine, spruce or hemlock sawdust is preferable. Hardwood sawdust is not recommended, as the grains are likely to be too small and too uniform in size. Sawdust obtained from the resaw, or from factories or mills is not usually suitable because the grains are too small. Before use, the sawdust should be screened through an ordinary mason screen of about ¼-inch mesh to remove the larger pieces of stringy bark. Water used for mixing should be clean. Portland cement is used.

Equipment.—It is absolutely necessary that the ingredients be mixed in a power-driven mixer in order to accomplish the desired results peculiar to cement-sawdust concrete. Containers of known capacity are required to measure the exact amount of water, cement and sawdust, as guessing at amounts results in a poor job. A wooden float and a steel float are required for proper finishing. In finishing, the wooden float is used first, and the steel float for the final operations. A light tamper is practically necessary in order to compact the material previous to finishing the surface.

Placing.—For floors for light service, a total depth of 3 inches is recommended. This should be placed in two layers, the first one 2 inches deep, with a surface layer 1 inch thick placed before the base has hardened, so as to obtain a good bond. It is preferable to place floors in small units, with contraction or construction joints placed vertically between the slabs. Slabs not larger than 12 feet square are recommended.

Proportioning the Mix.—The amount of water for a given amount of cement is the most important item in obtaining the desired strength. This is true in all concrete work, and especially so in cement-sawdust concrete. Too much water weakens the mixture, which should be workable but not sloppy. The amount of water in the sawdust is important.

Sawdust in piles always contains more or less water, this varying from 15% to 200% of the weight of the dry sawdust. Dry sawdust will absorb and hold 100% of its weight of water without liberating any of this water for the cement, and if the sawdust is too dry, it will rob water from the cement. The moisture content of the sawdust may be determined and the amount of water necessary computed. A simpler method is as follows: Place all of the sawdust to be used in one pile. Using a bushel measure, weigh a container level full, loose measure—do not tamp. Repeat the operation two or three times, taking the sample from separate parts of the pile. Take the average weight of all the samples, and from the table, detemine the amount of water to be added for each bag of cement, using the figures in the left hand column if the mix is 1 part of cement, by volume, to 3½ parts of sawdust, loose measure; those in the right hand column if the mix is 1:3.

Determination of proper water content is important. If the sawdust becomes wet from rains or dried out by sun and wind, new determinations for water should be made.

Mixing.—The cement and sawdust are placed in the concrete mixer and mixed dry for about 30 seconds. The water is then added gradually and the mixer contents are mixed for about 4 minutes, or more. After mixing, the material has the appearance of whipped cream, and is ready to be placed.

A wearing course containing sand has some advantages in resisting abrasion. It is used generally only for the 1-inch surface. Usual mix proportions are 1 part of cement, 1½ parts of sand and 3½ parts of sawdust, by volume. No additional water above that shown in the table is necessary.

Placing and Curing.—The mix is first spread with a long-handled wooden float, and then finished as already directed. Sawdust concrete cures more slowly than ordinary concrete; it should be kept damp for at least 7 days, and protected from the sun. As soon as the material hardens to the touch, normally in about 12 hours, it may be covered with an inch of loose sawdust and sprinkled with water. At the end of the 7-day period, the sawdust should be removed, and curing allowed to proceed for another 3 days; at the end of the 10-day period, it may be put into use, but complete curing requires about 28 days. Sawdust-concrete structures should not be built when temperatures are likely to go below 50°F during the 7-day period.

Quantity of Materials Required.—For each cubic yard of completed sawdust-concrete, about 7½ bags of cement and 30 cubic feet of sawdust will be required. One yard of sawdust and 7 bags of cement will make about 25 cubic feet of concrete.

Other Mixes.—If a 1:3 mix is desired, using one part of cement and 3 parts of sawdust, mixing, placing and curing follow the outlines already given. The amount of water required varies somewhat, as shown by the table. The quantities of materials required are also different. If it is desired to add sand, using a 1:2:3 mixture, about 10 bags of cement, 18 cubic feet of sand and 28 cubic feet of sawdust will be required to make 33 cubic feet of mix. No additional water above that shown in the table will be required on account of the sand admixture.

Cement-sawdust should be used with care. It has value in certain types of work, but it should not be employed under any circumstance as a substitute for the usual concrete made by adding cement, sand, stone and water, especially where structural strength is desired.

Coal Used to Heat Asphalt Is Covered by Bond

Coal furnished to a highway construction contractor and used by it to heat the asphalt in spreading it as top surface on the highway was held to be "material furnished" in the "carrying forward, performing or completing of the contract," the statutory coverage in the contractor's bond under the Ohio statutes (Lingler v. Andrews, 10 N. E. [2d] 1021) the bond being made to take the place of the Mechanic's Lien Law where no lien could be had by reason of the work's being public works construction. The material, the coal, was entirely consumed in melting the asphalt to prepare it for spreading; and the heat produced from the coal had gone into the materials for the completing of the contract.

Practices in Sewer Construction in Wet Ground

SOME cities employ no special construction for sewers laid in wet ground, but use the customary vitrified clay or concrete pipe jointed with cement mortar. Others take special precautions, such as use of cast iron pipe, of bituminous or Weston type joints, etc. In the following notes, clay or cement pipe with cement joints will be assumed to be standard.

Replies to a questionnaire on the subject have been received from 991 cities. In tabulating these, we have grouped them by states, to indicate the effect of geographical location on practice.

Alabama.—Eight cities reporting; three use asphalt joints in wet ground; three inspect sewers from manholes for infiltration; one plugs line and fills. *Arizona.*—Five cities reporting; two use bituminous joints. *Arkansas.*—Seven cities reporting; one uses cast iron pipes; two use special joints; four test for infiltration, one by flooding the trench, two by inspecting at manholes.

California.—Seventy-four cities reporting; eight use cast iron pipe in wet ground; thirty use bituminous or Weston joints; methods of measuring infiltration include V-notch weir, filling line with water, and inspection from manholes, these being practiced by twenty cities. *Colorado.*—Sixteen cities reporting; two use special pipe; four special joints; one tests infiltration. *Connecticut.*—Fourteen cities; one uses cast iron pipe; twelve use special joints, including Weston, GK, tar and asphalt; seven check for infiltration, including weirs, plugging lines and measuring drop, and inspection.

Delaware.—Three cities; one of which uses asphalt joints; two check infiltration. *Florida.*—Twelve cities; one uses cast iron pipe; eight use special joints; five check infiltration. Clearwater limits leakage to 5 gallons per foot per day. *Georgia.*—Eleven cities; two use cast iron; three use special joints; two check infiltration. *Idaho.*—Six cities; three using bituminous joints; one checks infiltration. *Illinois.*—Forty-one cities; three use special pipe; fourteen use bituminous joints; twelve test for leakage; four check for infiltration. *Indiana.*—Twenty-three cities; one using cast iron and five special joints; four check infiltration. *Iowa.*—Thirty-four cities; two using cast iron or steel where needed; twelve use special joints; eight measure infiltration.

Kansas.—Thirty cities; five use cast iron; ten use bituminous joints; seven check the amount of infiltration. *Kentucky.*—Sixteen cities; two use cast iron in wet ground; ten use special joints; five measure infiltration. *Louisiana.*—Five cities; no variations; one tests for infiltration. *Maine.*—Six cities; one uses double strength tile; one uses bituminous joints. *Maryland.*—Two cities; one uses bituminous and lead joints; both measure infiltration by weir. *Massachusetts.*—Thirty-eight cities; five use cast iron; twenty-three use bituminous joints; seven check amount of infiltration.

Michigan.—Forty-four cities; no variations in pipe; twenty-four use special joints; thirteen check amount of infiltration. *Minnesota.*—Thirty-six cities; three use cast iron in wet ground; ten use special joints; seven measure infiltration. *Mississippi.*—Six cities; one user of cast iron pipe; two use special joints; one measures infiltration. *Missouri.*—Twenty-one cities; two use cast iron; nine use special joints; two measure infiltration. *Montana.*—Eleven cities; one uses cast iron pipe; two use special joints; two measure infiltration. *Nebraska.*—Twenty cities; three use cast iron; four use special joints. *New Hampshire.*—Five cities; two use cast iron; one uses special joints. *New Jersey.*—Thirty-nine cities; eight use cast iron; thirty-two use special joints; nineteen check infiltration. *Nevada.*—Two cities; no variations.

New Mexico.—Six cities; two use special joints; one checks infiltration. *New York.*—Fifty-eight cities; ten use special pipe, including cast iron, Armco coated and Transite; thirty-nine use special joints; eighteen check or measure the flow due to infiltration. *North Carolina*—Thirteen cities; two use special pipe (cast iron); none uses special joints; three measure infiltration in new lines. *North Dakota.*—Ten cities; several report no wet ground; none use special pipe; two use special joints. *Ohio.*—Fifty-three cities; one uses cast iron in wet ground; twenty-five use special joints; thirteen check infiltration.

Oklahoma.—Sixteen cities; two use special pipe; five use special joints; three check infiltration. *Oregon.*—Thirteen cities; none report using anything but concrete or vitrified pipe; no special joints; four check infiltration. *Pennsylvania.*—Ninety-eight cities; thirteen use special pipe; fifty use special joints; twenty-eight check for infiltration. *Rhode Island.*—Six cities; one uses transite; two use special joints. *South Carolina.*—Seven cities; two use cast iron and lead joints in wet ground.

South Dakota.—Twelve cities; two use special joints; two check infiltration. *Tennessee.*—Nine cities; three use special pipe; two use special joints; three check infiltration. *Texas.*—Thirty-seven cities; four cities use special pipe, ten special joints; five check infiltration; several cities report no wet ground. *Utah.*—Seven cities; four use special joints; two check infiltration. *Vermont.*—Four cities; one uses asphalt joints.

Virginia.—Seventeen cities; one uses cast iron pipe; eight use special joints; eight check infiltration. *Washington.*—Twenty-four cities; one uses cast iron pipe; seven use special joints; four check infiltration. *West Virginia.*—Five cities; one city uses cast iron pipe with lead joints, and tests for infiltration. *Wisconsin.*—Forty-one cities; six use special pipe, thirty use special joints and nineteen check infiltration. *Wyoming.*—Seven cities; three use cast iron with lead joints and one checks infiltration.

Some kind of test is made for leakage by 252 cities. 58 by observation or inspection; 34 block off a section and measure flow before connections are made; 33 plug the line and fill it with water; 26 use a weir in manholes or in the sewer; 25 measure the flow or amount pumped; 16 compare flows at different points; 9 flood the trench and note infiltration; 4 flood the backfill and inspect; 4 inspect the interior of the pipe by lamps or mirrors; and 43 do not specify the method.

The Waterworks Digest

Abstracts of the main features of all important articles dealing with waterworks and water purification that appeared in the previous month's periodicals.

V-Notch Weirs At Low Heads

Experiments indicate that dependable measurements can not be made with V-notch weirs operating under heads less than 0.3 ft. unless they are carefully calibrated and the conditions during use duplicate exactly those during calibration; and even then large errors must be expected. The error is apparently due to the fact that at low heads the nappe clings to the face of the weir plate.[L12]

Electrode Potentials In Chlorine Solutions

Measurement of electrode potentials is valuable as an indicator of the extent to which the effectiveness of a chlorine residual is modified by the chemical composition of the water. Operating difficulties caused by false or misinterpreted orthotolidine tests can be minimized if potential measurements are carried out in addition to residual tests. Use of such measurements enhances the safety factor of operation because, in contrast to the orthotolidine residual method, the operator is forewarned of changes in the chemical composition of the water that may affect the amount and bacterial effectiveness of the chlorine residual.[A124]

New Method of Designing Cast Iron Pipe

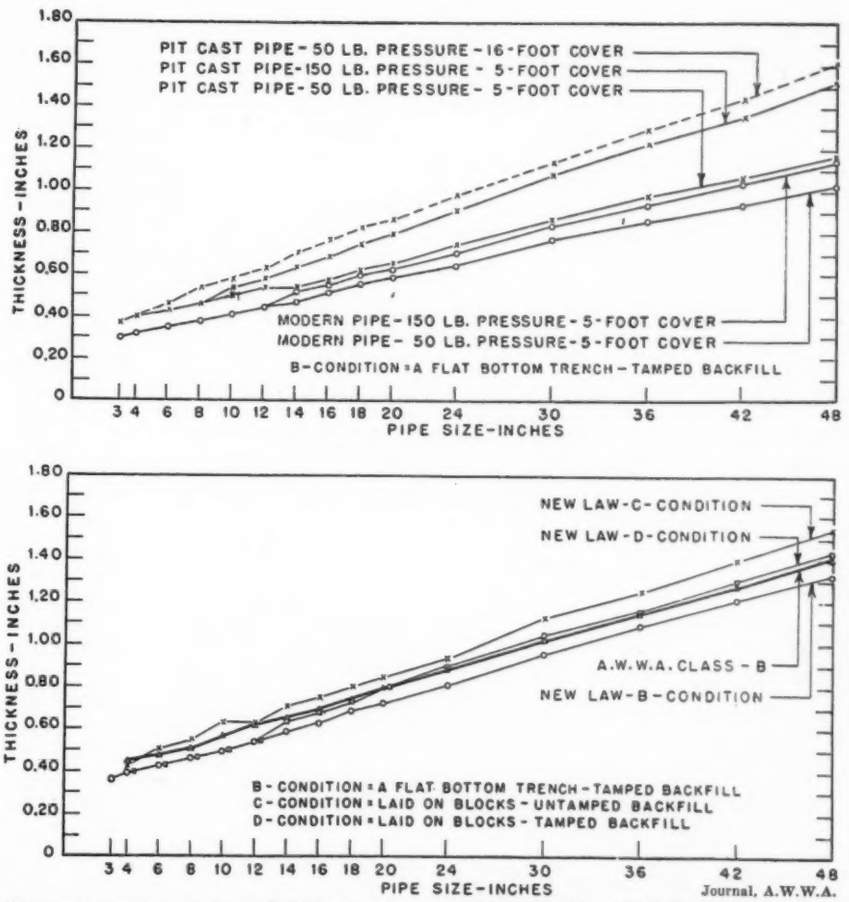
After 13 years of intensive work, the American Standards Association's Sectional Committee A21 has developed a new method of calculating thicknesses of cast iron pipe, which emphasizes the importance of external loading on the pipe line and the fact that the external load conditions as well as internal pressure must be considered if safe, and at the same time economical, design of wall thickness is to be obtained. In figuring on external loads, allowance is made for two 5-ton trucks passing simultaneously. A factor of safety of 2½ is used for both internal pressure and external loads. Pipe designed by previous formulas on the basis of pressure alone may for some trench conditions be uneconomical and for others inadequate; although for average field conditions the new method gives thicknesses not departing radically from existing standards. The new law "establishes a rational method of calculating to a high degree of accuracy the extent of the external loads encountered in service, and their effect to stress the pipe as influenced by the method of laying." (The method of determining the external loads is similar to that developed for sewer pipe by Iowa State College and in use for a number of years.)[A130]

New Specifications For Gate Valves

Specifications for gate valves adopted in 1939 by the A.W.W.A. and N.E.W.W.A. add to the old specifications requirements for thickness and disposition of metal in bells, dimensions and drilling of flanges, compressive strength of gate rings, spot-facing of oversize flanges, back-facing of body rings, thickness of body and bonnet shell; types of gates, rings, wedging devices, guides, tracks, stuffing boxes, gears, indicators, bypasses, thrust bearings and gaskets are described; stronger metal is required for bodies, bonnets and valve stems; and some others.[B41]

Laying Steel Mains in Two Cities

Needham, Mass., and Augusta, Me., last year laid steel pipe 14" and 8" diameter, respectively, the former lined with Bitumastic enamel, the latter with Barrett coal-tar enamel, both wrapped by Hill, Hubbell & Co., with



Above—Comparison of pipe wall thicknesses by new and by old design, with 5 ft. and 16 ft. cover. Below—Comparison of thickness by new and old design under three conditions of laying.

asphalt, rag felt and Kraft paper. In handling, Needham used slings run through old fire hose, and hose was fastened to the truck bolsters on which the pipe rested while being delivered. In both cities Dresser couplings were used; a special adaptor for connecting the steel pipe to existing cast iron pipe; gate valves had half a Dresser coupling incorporated at each end. In Needham, 4 or 5 40-ft. lengths of pipe were coupled above the trench and lowered by slings; in Augusta this was not done, to minimize the length of open trench and interference with traffic. Augusta laid services from this line to every property; for those on the opposite side of the new concrete pavement they drove 2″ steel service pipe by means of air jets in sand or hardpan, by water jets in clay, feeding three properties from each such service; connecting services to the main by means of malleable iron tapping saddles.[B28 & 29]

Upward-Flow Clarification in Softening

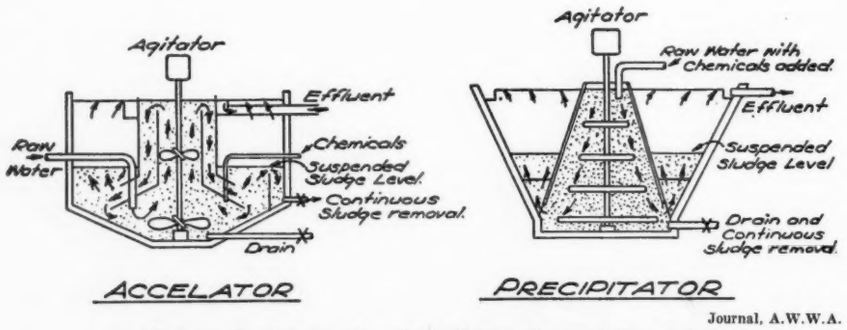
Upward-flow lime softening and coagulation settling tanks have been in operation at the St. Petersburg, Fla., water works for over four years. In these, aerated water flows to a well in the center of the tank, (receives a dose of milk of lime in the softening tank), and swirls downward to the bottom, where it passes into about 100 radial distributor pipes laid on the tank bottom and through orifices in these into the tank; passing through a stratum of previously precipitated calcium carbonate sludge which collects in the bottom of the tank. The sludge is drawn off about every three days. The engineers "are convinced that the upward flow design for chemical reaction and settling offers more economies and efficiency than can be obtained from horizontal flow basins or tanks. . . . Turbidity and color removal, softening, iron removal and certain types of waste disposal which involve coagulation and concentration of the precipitated sludge are some of the more common types of treatment which adapt themselves to efficient handling by the upward-flow method."[A137]

Upward filtration through sludge is employed in two recent devices—the "accelator" and the "precipitator." In the former there are two concentric tubes in a cylindrical tank. Raw water and chemical are discharged at the bottom of the central tube; rise in and overflow the top of this, and the mixture passes down through the annular space between the tubes; then rises through the sludge between the outer tube and the side of the tank and is drawn off. In the "precipitator" the tank is an inverted truncated cone containing an erect truncated cone. Raw water and chemicals enter the top of the inner cone, pass down and under its bottom, and up between the two cones, passing through the sludge collecting there. In each design, the water and chemical are mixed by a motor-driven agitator in the inner tube, and sludge removal is continuous. The total time for mixing and clarification is about an hour. Engineers of the Illinois Dept. of Public Health believe that "short-time upward-flow treatment appears to offer a method of solving some of our water treatment problems in an efficient and economical manner. . . . The basic principle of short-time upward-flow softening gives fair promise toward the complete elimination of recarbonation, even in high magnesium waters requiring excess lime treatment."[A136]

Cement Lining Iron and Steel Pipe

Iron pipe 3″ to 12″ diameter in place and having deposits or tubercles can be cleaned and lined with cement ⅛ to ¾ in. thick by the Tate process at a cost approximately ¼ that of renewal. A 5″ pipe so treated had its carrying capacity increased from 97 gpm to 261 gpm, with a Williams & Hazen coefficient of 157 calculated on actual diameter of lined pipe.[B31]

Pipe 36″ diameter and greater (generally of steel) are lined by a centrifugal machine that throws cement against the pipe and trowels it smooth. A 48″ steel main after 40 yrs. service was cleaned of a ton of tubercles for each 257 ft., lined with cement ¼ in. to 1 in. thick, and its coefficient increased from 70 to 124. In one case, 21,000 ft. of 48″ pipe was lined in 25 8-hr. shifts.[B32]



Journal, A.W.W.A.

Diagrams showing operation of two designs of upward-flow tanks

Maintaining Compressed Air Equipment

The Hartford, Conn., Water Dept. operates five air compressors, each carrying 2 paving breakers, 2 clay diggers, 2 tampers, a sump pump, and air-caulking and chipping hammers. Each compressor is given a 4-hour inspection and checkup every fifth week; air output is measured and engine gone over, oil changed, carburetor cleaned, etc. Each air tool is tested for air consumption, a flatpointed moil being placed in the breaker and worked in a lead pot for 10 seconds, a 2″ penetration with not more than 68 cfm of air being required. Clay diggers and tampers also are tested for air consumption and the sump pumps are tested in a tub of water.[B39]

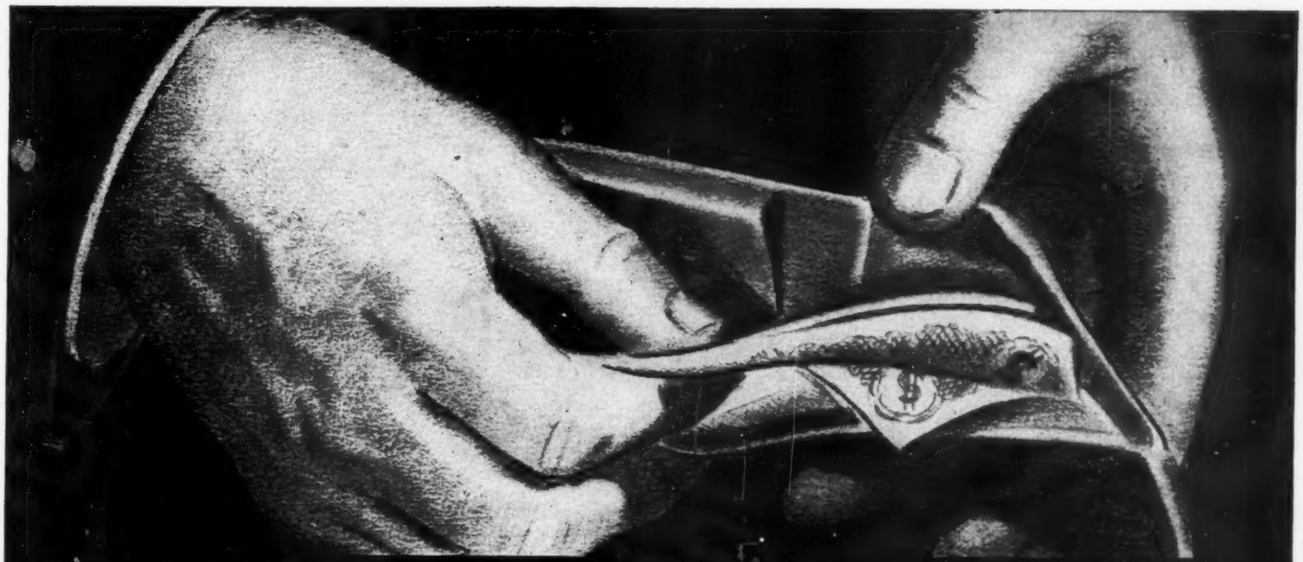
Life of Water Mains

Based on complete records of mains in the Springfield, Mass., water system over a 72-yr. period, determinations of average service lives and estimates of structural lives of cast iron, wrought iron, steel and cement mains have been made. The system contains about 275 miles of 4″ to 42″ cast iron, 20 miles of 8″ to 72″ steel, 16 miles of 1″ to 2″ wrought iron. About 44 miles of 2″ to 24″ cement mains have been retired, but nearly 4 miles of 24″ cement-wrought iron laid in 1874 is still in service.

Retirement, or the termination of service life, is in some cases due to structural failure, but is more often due to desire for larger size; due to growth of population or other uses of water, to desire for increased pressure, to changes in street grades, change in source of supply, extensions of the system to new areas, etc.

The 1″ to 2″ w. i. or steel pipe is usually laid as a temporary line to serve scattered users. While the average service life at Springfield was about 19 to 23 years, it was estimated that the smaller size might serve for 50 years and the 2″ for 60 years.

Springfield has replaced all of its 3″ and nearly half of its 4″ mains with larger sizes; the service life of these small sizes is therefore low, the average life is estimated to be 51 years. The average life of 6″ is estimated to be 140 to 150 years; and of 8″, 160 to 170 years; while for larger sizes the life would be still longer, some of it



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serving into "the dimly distant future." In view of the present practices for preventing corrosion, the service life of cast iron pipe "will universally tend to approach those resulting from necessary replacements due to changes in demand conditions. And increase in population as a cause of retirement is decreasing rapidly — may even disappear."

These facts should be considered in providing for depreciation reserves, or reserves may become unnecessarily large decades before they are needed.[A129]

Aging of Reservoirs

Chemical and physical characteristics of impounded waters change during storage, most of the changes being beneficial. At the Wanaque reservoir, in northern New Jersey, which went into service in 1929, it was found that when the storage ratio is approximately 1.0, the minimum color was reached in 7 years; in an unused reservoir of low storage ratio, the color aging time may be as short as 4 years—less if the flooded areas have been stripped. Iron, manganese, and other mineral salts show vast improvement in 3 years. CO_2 reached a nearly stable minimum in the 6th year. After the first 3 years dissolved oxygen was always present, even in the bottom water. Hydrogen sulfide was present at all depths during the summer and fall of the first year and in the bottom water two years longer; but there has been none even in the bottom after the 3rd year. The number of micro-organisms may be excessive at times even in old reservoirs; but especially so the first year if filled during a growing season.[A140]

Porous Plates For Filter Bottoms

Sand filters at Larchmont, N. Y., built in 1929 with wrought iron manifolds, were overhauled and numerous orifices in the laterals found completely sealed by scale and corrosion. Two years after rebuilding, hard spots again developed in the sand beds. One of the 4 units was rebuilt using Norton porous plates in place of gravel. Vertical rods were screwed into the bottom of the filter box 12″ apart in rows 12″ apart, but staggered so that, while one row would support the corners of the plates, the next row would come at the middle of the side, thus giving each plate 3-point support. The rods were supplied with metal washers near the top to support the plates, and a washer and nut on top of the plate, with a sponge rubber washer between each metal washer and the plate. This provided a false bottom over the entire tank floor, on which 24″ of sand was placed directly. The joints between abutting plates and between plates and walls were sealed with a hot plastic composition. All metal supporting fittings were of "Everdur". The plates supply wash water at a rate higher than the wash gutters will function normally. After several months' operation results appear to be satisfactory.[F89, G45]

Durability of Rubber Pipe

The use of rubber pipe for short water mains has been referred to previously in the "Digest". Tests of the durability of 4″ rubber pipe were made last year in Singapore, and in his annual report A. R. Fyfe, municipal engineer, says that a 4″ rubber pipe with gun-metal connections was placed in the sea in May, 1935, at the mouth of the Singapore river, where conditions were particularly bad. This was removed in October, 1938, and tested to a pressure of 100 lb., which was maintained for 5 minutes, then fell 15 lb. in 15 min., then remained constant. The loss was due to the failure of two of the three bands clamping the pipe to a gun-metal spigot. There was a tear

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4" long in the outer skim of the pipe due to rough handling but no leakage there or sign of deterioration. Apparently "reinforced rubber pipe stands up well. The troubles experienced have all been in any exposed metal."[D33]

Bibliography of Waterworks Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

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October

129. Service Lives of Mains, As Indicated by a 75-Year Retirement Record. By R. Newsom and E. H. Aldrich. Pp. 1625-1654.
130. t Discussion of the New Law of Design of Cast Iron Pipe. By W. D. Moore. Pp. 1655-1674.
131. Centrifugal Pumps Designed for Underground Waters. By A. O. Fabrin. Pp. 1675-1683.
132. Vertical Pump Applications. By J. H. Coffey. Pp. 1684-1690.
133. Fundamentals of Water Pretreatment. By F. Bachmann. Pp. 1691-1702.
134. Coagulation of Soft Water with Iron Salts. By G. E. Willcomb. Pp. 1703-1722.
135. t. Iodide Technic for Colorimetric Determination of Chlorine in Water. By F. W. Gilcreas and F. J. Hallinan. Pp. 1723-1733.
136. Illinois' Experiences in Lime Softening with Short-Time Upward-Flow Clarification. By. H. A. Spafford and C. W. Klassen. Pp. 1734-1754.
137. Performance of Upward Flow Basins at St. Petersburg, Fla. By R. W. Sawyer. Pp. 1755-1762.
138. Standard Classification of Accounts and Standard List of Retirement Units. By L. D. Blum. Pp. 1763-1768.
139. Consumers Accounting and Collecting. By M. F. Hoffman. Pp. 1769-1774.
140. The Aging of Reservoir Waters. By L. T. Purcell. Pp. 1775-1806.

D *The Surveyor*
October 20

33. Singapore Municipal Services. P. 359.

E *Engineering News-Record*
November 9

41. Fifty Years of Waterworks Advance. By M. N. Baker. Pp. 53-54.
42. Removable Well Houses Simplify Maintenance. Pp. 78.

F *Water Works Engineering*
October 28

86. New Building for Mt. Prospect Laboratory. By F. E. Hale. Pp. 1362-1365.
87. p. Rapid Sand Filters at Lawrence. By A. L. Shaw and E. S. Chase. Pp. 1366-1369.

November 18

88. Columbus, O., Department Practices and Repair Shop Methods. By N. N. Wolpert. Pp. 1422-1425.
89. False-Bottom Porous Plate Filter. By H. T. Hotchkiss, Jr. Pp. 1426-1427.
90. p. Water Treatment Experiences in New York State. By C. R. Cox. Pp. 1432-1434

G *Water Works & Sewerage*
November

43. Architectural Concrete in Water and Sewage Works Construction. By W. D. M. Allan. Pp. 427-430.
44. The Blue Ridge Tank of Indianapolis. By M. Hamilton. Pp. 431-434.
45. Porous Plate Filter Bottom at Larchmont, N. Y. By H. T. Hotchkiss. Pp. 442-444.
46. p. Simple Method for Checking Pump Efficiencies. By H. E. Beckwith. Pp. 445-449.
47. p. Enslow Continuous Stability Indicator. By R. J. Leveque. Pp. 450-451.
48. Watching Your Cash Register. By D. R. Taylor. Pp. 452-454.
49. p. Water and Sewerage System Safety. By C. A. Hechmer. Pp. 459-461.

M *Canadian Engineer*
November 14

10. Caron Water Storage Project. By J. I. Strong. Pp. 2-5.

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November

25. Aeration and Iron Removal for Small Water Supply. Pp. 37-38.
26. Spheroid Water Tank in Brookline, Mass. Pp. 53-54.
27. Water Rates and Service Charges. Pp. 75, 77, 79, 81, 83.

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November

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15. Possible and Probable Future Floods. By W. P. Creager. Pp. 668-670.

Public Works
November

46. 21-Mile Concrete Pressure Pipe Line and Dam Feature Bethlehem's New Water Supply. Pp. 9-12.
47. Method and Practices in Sterilizing Newly Laid Mains. Pp. 24-26.
48. Cathodic Corrosion Elminators at Treasure Island. P. 30.

V *Journal, Maine Water Utilities Ass'n.*
November

4. Corrosion Prevention with the Rustop System. By E. H. Ingle. Pp. 148-153.

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August

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Year of 1939

3. t. Fundamentals of the Chemistry of Water. By J. J. Shank. Pp. 49-54.
4. A Simple Method for Testing Centrifugal Pumps. By H. E. Beckwith. Pp. 55-66.
5. The Functions, Use and Operation of Automatic Valves. By W. F. End. Pp. 67-86.
6. Porous Plate Underdrain System for Rapid Filters. By F. C. Roe. Pp. 87-90.
7. Use of Modern Agitation in Filter Washing. By C. E. Palmer. Pp. 91-102.
8. The Arithmetic of the Filter Unit. By H. G. Turner. Pp. 103-113.
9. Symposium on Water-Borne Diseases. By A. E. Griffin, J. E. Beitz, R. I. Dodd, E. C. Goehring, H. J. Krum, P. P. Merkel, G. G. Schaut, J. J. Shank, G. R. Taylor, E. C. Trax. Pp. 114-138.

The Sewerage Digest

A Digest of the Sewerage Literature of the Month giving the main features of all the important articles published

Lining an Abraded Sewer

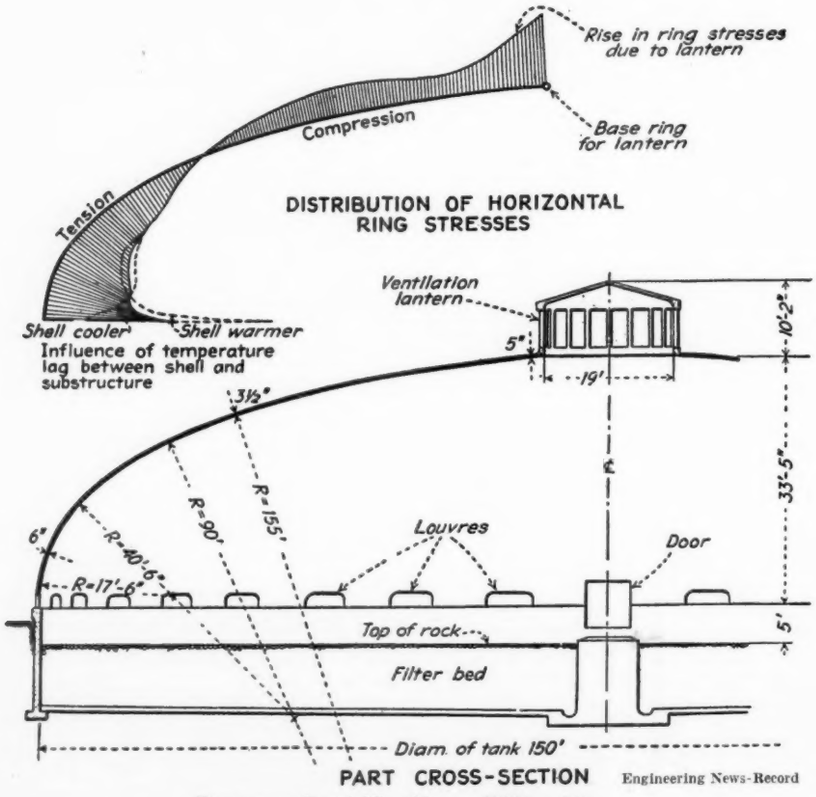
Sand, brick and other abrasives carried by sewage pumped through 4,000 ft. of 48″ cast iron sewer in New Orleans eroded a channel about 18″ wide in the invert, reducing the thickness from the original 1⅛″ to as little as ¼″ in places, and causing failure under pumping pressure. Concrete lining was tried and resisted scouring but not internal pressure. Repair was finally made by fastening cast iron plates to the inside of the sewer. Cost $50,000; cost of replacement would have been $700,000.[E30]

Dome Cover For Trickling Filter

Two trickling filters at Hibbing, Minn., have been covered with elliptical concrete domes 150 ft. in diameter and 32 ft. high. Purpose, to prevent ice formation on the filter and so increase efficiency, and prevent interference with distributors by wind, snow and ice. The elliptical form possessed several advantages over a shallow segment of a sphere, and a hemisphere 75 ft. high would be uneconomical. A large lantern at the top and 35 louvre openings 6 ft. wide by 2 ft. high around the base provide ventilation. About half the concrete shell is 3½″ thick, increasing to 6″ at the base and 5″ at the ring that supports the lantern. The cost, including two coats of emulsified asphalt and one of aluminum paint, was 75 cts per sq. ft. of area covered.[E31]

The Biofiltration Process of Treatment

This involves presettling, application to a trickling filter, and recirculation of filter discharge back to settling tank. Purpose: To reduce size of trickling filter necessary, and permit obtaining greater efficiency under varying conditions. Complete stabilization is not secured in the filter alone, but is completed in the settling or detention tank. Eleven plants are in operation and 6 more under construction—14 in Calif., 2 in Wash., 1 in Colo. Three arrangements are suggested: I—One clarifier and one filter, giving a B.O.D. reduction greater than sedimentation, less than standard trickling filter. II—The same, with an additional clarifier, giving 80 to 85% B.O.D. reduction. III—Two clarifiers and 2 filters, giving 90 to 95% reduction, comparable to activated sludge. The dosing rates are commonly between 20 and 60 mgad, with recirculation ratios of 1:1 to 1:3. B.O.D. removals range from 1 to 3 lb. per cu. yd. of filter media per day. The process may be used for pretreating sewage in overloaded activated sludge or trickling filter plants, especially if the sewage is strong or subject to extreme fluctuations of industrial wastes. Comparing cost with trickling filter, construction is estimated 30% less, operation 15 to 20% less. Compared with activated sludge, first cost is about the same, operating cost 30 to 50% less.[H55]



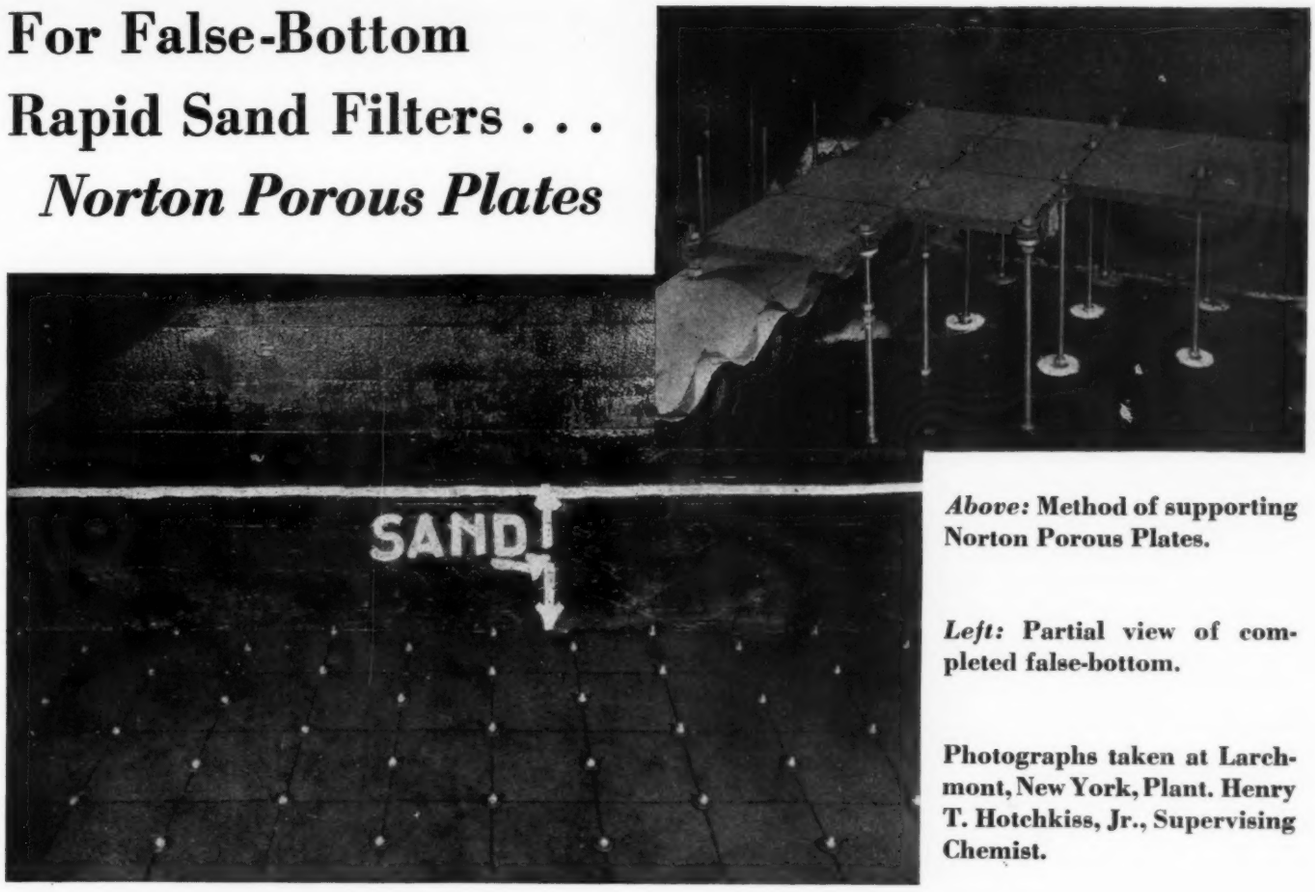
Dome cover for trickling filter at Hibbing, Minn.

Practice in Activated Sludge Treatment

More than 200 activated sludge plants are in operation in the United States with a total nominal capacity of about 1700 mgd. The largest is the Chicago Southwest, 400 mgd. Most have coarse screens, grit chambers and settling tanks; a few have pre-aeration for grease separation to prevent the inhibiting effect of grease film on rate of oxygen absorption by sludge floc. Preliminary sedimentation gives the sewage more uniform characteristics, reduces volume of activated sludge and of air required. Depth of aeration tanks varies from 11.5 ft. to 17.33 ft. —most between 16 and 17 ft. Width varies from 10 ft. to 33 ft.; length from 67.5 to 434 ft. In many plants there is automatic regulation of air feed and of sludge withdrawal and return. Variation in rate of returning sludge is obtained by use of variable-speed pumps or operation against a variable head. Centrifugal air blowers, driven by either steam turbines or motors, are used in the 9 largest plants; rotary positive displacement blowers in most of the small ones. "In general, the design of large blower installations requires most careful atten-

For False-Bottom Rapid Sand Filters . . .

Norton Porous Plates



Above: **Method of supporting Norton Porous Plates.**

Left: **Partial view of completed false-bottom.**

Photographs taken at Larchmont, New York, Plant. Henry T. Hotchkiss, Jr., Supervising Chemist.

THE rapid sand filtration method of water treatment is an important problem of many municipal engineers.

Camp process has introduced marked improvements in this system of filtration due to the use of Norton Porous Plates.

First, the inherent qualities of the plates make them peculiarly adaptable to this type of work. They are strong and uniform; and can be furnished in the desired structure.

Second, the patented Camp bottom is adaptable to old installations (see illustrations). This false-bottom design provides equal rates of flow of wash water through every square inch of bottom—an important factor in long life and efficient filter operation.

If you are operating rapid sand filters or contemplating their construction you'll want more information about Norton Porous Plates.

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NORTON POROUS MEDIUMS

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tion if operating economy is to be realized." "The final sedimentation step of the process deserves special attention if a clear effluent, free from floc, is to be secured." The settling rate is generally 900 to 1000 gal. per sq. ft. daily, average mixed liquor basis, or 1600 to 1800 maximum mixed liquor basis. Waste sludge is returned to preliminary settling tanks in many plants but not in the 10 largest. Six of the largest dewater sludge by vacuum filters, as does also Ann Arbor treating only 4.5 mgd of sewage. Sludge is incinerated at 4 of the largest plants; made into commercial fertilizer by one of them (also by 2 smaller plants); given to farmers by 2 of these largest and most of the smaller ones.

The process is harmfully affected by septic raw sewage, variations in quantity and strength of incoming sewage, return of strong digestion supernatant to preliminary sedimentation, and relatively large proportions of certain industrial wastes, especially from metal works, dairies and textile mills.[K5]

Contact Aeration Sewage Treatment

Based on 5 yrs. experience with a pilot plant at Waco, Tex., a plant is proposed by Clyde A. Hays using, for secondary treatment, two aeration tanks in tandem. The first is divided into two tanks of equal size separated by a submerged weir, each containing vertical sheets of aluminum spaced 2" apart, connecting the side walls and extending from 2" below the water surface to almost the bottom of the side walls. Each also has a hopper bottom. The second tank also is divided into two, each filled with 2½"-3½" stone supported on a bottom grill of steel rails. Air is supplied to all four tanks, through pipes at the bottom, at 3.4 lb. pressure, the total amount used being 1 cu. ft. per gallon of sewage treated. The object is to secure the development of four different groups of aerobic organisms, one in each tank. Suspended and colloidal matter collecting on the plates falls off at intervals into the hoppers, from which it is pumped to a digestion tank. It is claimed that this process requires only half as much space as activated sludge and half as much power; costs two-thirds as much, gives as good an effluent, does not require skilled operators and is especially suitable for milk, brewery and other wastes.[X19]

Bulking and Supernatant

At San Antonio, Tex. addition of too much digester supernatant to the primary clarifiers is believed to be a cause of bulking. "Once activated sludge is in good condition, quite an amount of digester supernatant is required to poison it and produce bulking; but if the sludge is always close to bulking due to continual slight underaeration it is sensitive to even small amounts of digester liquor. If the amount of digester liquor is not carefully controlled, the sludge index will soon increase above 200 and plant performance goes down." Twice when so poisoned it was some months before the sludge index dropped and then only after a decided increase in the amount of air per pound of B.O.D. load.[X20]

Irrigation In Texas

Kingsville, Tex., treats 400,000 gpd by irrigation on 320 acres. Untreated sewage is pumped onto the land, any temporary surplus going to a lake of 12 acres area to be used on the same land later. Considering loss through seepage and evaporation, the lake permits at least 90 days' storage; it absorbs oxygen from the atmosphere and minnows live in it. The land is planted to Rhodes grass and hegari and part as plain pasture for cattle. In 1938 the value of crops raised was $12,860. There are never objectionable odors from land or lake. Applications to land are made quickly and soak in rapidly. The cost is 24 cts. per capita

per year for labor and power for pumping. Success or failure in various places seems to be due entirely to the interest the operator takes.

Munday, Tex., places 55,000 gpd. on 15 acres regularly; in wet weather flows it onto another 9 acres of sandy soil. Cotton is the crop preferred, because it can be plowed between the rows for cultivating; corn and maize grow too rank to permit this. Irrigated land yielded about 1 bale to the acre; unirrigated about 1/3 bale in a dry year.[X25]

Grape Fruit Canning Plant Wastes

Average wastes of this kind run 400 to 4,000 ppm of B.O.D.; dehydration plant wastes, 8,000 to 80,000 ppm. Acidity runs as high as 2,000 ppm. A day's run of 50 to 100 tons of fruit produces a young mountain of peel, fills the air with a pungent odor and produces countless vinegar flies. Individual treatment at the plants includes screening through 40-mesh rotary screens, coagulation with alum and lime; giving 50 to 89% reduction of B.O.D. and relative stability of 50 to 99%. In an experimental plant by the Texas Bd. of Health, 400,000 gpd. of waste is run to a central sump which receives also treated domestic sewage for dilution; dosed with alum, lime and activated carbon and pumped to one of two 135,000 gal. settling basins, giving 7 to 13 hrs. detention. These discharge through an aerator, then chloride of lime solution is added. Part of the basin effluent is passed through filters with different kinds of media. Average B.O.D. reduction about 70%. [X26]

Treating Packing Plant Wastes

The chief problem is disposing of the sludge. The Tovera Packing Co. of Phoenix, Ariz. treats it in double digestion tanks, utilizing the gas; 26 days in the primary digester, 4 days in the secondary; 20 to 50 days on drying beds. In the Hormel process, wastes pass through a primary tank, where heavy solids and grease separate out; chlorine is added to the effluent, and more solids precipitated in a secondary clarifier; 30 min. in the primary clarifier and 45 min. in the secondary. The liquid is passed through the process quickly, for the amount of protein precipitated by the chlorine is reduced if the liquid stands in the primary basin long enough for protein decomposition to take place. Suspended solids are reduced 98%, organic nitrogen 70 to 75% and B.O.D. 75%. The Kerber Packing Co. uses a similar plant, but ferric chloride instead of chlorine. In the Tovera system the waste passes through a bar screen; ferric chloride is mixed with it in a Dorrco flocculator; then it stands 90 min. in a sedimentation tank. The effluent, with a B.O.D. of 200, is used for irrigation. [X27]

Safety in Sewerage Systems

Before a man enters a sewer, several manholes nearest to the one he enters should be opened, and air blowers forcing air to where the man works are an added precaution. Safety belts in deep manholes are desirable. So are instruments for detecting explosive and toxic gases, and permanent installations of gas detectors in pumping stations and disposal plants, with automatic alarms. Warning signs for traffic should be placed some distance from sewer excavations where these are on or near vertical or horizontal curves.[G43]

Sanitary Fill In San Francisco

Since 1932 San Francisco has disposed of about 600 tons of garbage

and rubbish a day by sanitary fill. The refuse is collected by scavengers and delivered to gondola cars of the Sanitary Fill Co. (to which they pay not over $1 a ton), wet down to prevent dust, covered with heavy wire netting and hauled 4½ miles to tideland. There it is unloaded by dragline cranes and pushed to the edge of the fill by a 75hp. tractor equipped with an extra-large bulldozer blade. A 60 hp. tractor trims the fill and covers it with earth, which is dug from an adjoining hill and distributed by four 6 cu. yd. dump trucks (which also make and maintain the dirt roads on the fill). An average of 580 cu. yds. of earth a day is used, or one cu. yd. to each ton of refuse. Twenty men are employed on the fill, including night watchmen and mechanics in the machine shop. The fill has, in 7 years, been carried 2500 ft. from shore with a uniform width of 1050 ft. It is estimated to be about 50 ft. deep, 25 ft. of which is below the original mud surface. The refuse compacts to about 37% of its loose volume the first year, and slowly thereafter. An odorless gas, probably methane, escapes at places. There are no rats. At certain times of the year flies are noticeable for a few hours while the garbage is being unloaded. Test pits in fill 5 yrs. old showed 2 ft. of earth cover, then 2 ft. of garbage, 18" of earth and 6" of garbage. Vegetables and paper had undergone practically no decomposition.[L6]

Plant Construction By the WPA-Contract Plan

In constructing a $67,000 treatment plant, Hoopeston, Ill. used the WPA-Contract plan, under which bids were received from contractors for furnishing all equipment, materials, tools, skilled labor and supervision, while WPA furnished the labor. The labor furnished all lived in Hoopeston or near by and were accustomed to doing the kinds of work provided by a semi-agricultural community; the work to be carried on 8 hrs. a day 6 days a week. The contractor had no complaints regarding the labor furnished. The only mechanical equipment on the project were concrete mixers, trucks, and a concrete elevator. The engineer's estimate of the total cost was $67,000, actual cost was $67,064.28. The construction cost was estimated at $62,000, actual cost $60,733.46, the remaining cost being for land, engineering and other items.[G41]

Bibliography of Sewerage Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

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November 10
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46. p. Some Comments on Recent Experiments on Activated Sludge. By H. H. Goldthorpe. P. 402.

E *Engineering News-Record*
October 26
29. n. Sanitary Survey of River at Grand Rapids, Mich. P. 57.
November 9
30. Cast Iron Liner Plates Protect a Sewer from Erosion. P. 52.
31. Elliptical Concrete Domes for Sewage Filters. By E. C. Molke. Pp. 59-61.
32. Notes on Sewage Disposal. By W. Rudolfs. P. 80.

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November
41. Hoopestown, Ill., Builds Sewage Treatment Works. By K. V. Hill. Pp. 423-426.
42. Architectural Concrete in Water and Sewage Works Construction. By W. D. M. Allan. Pp. 427-430.
43. p. Water and Sewerage System Safety. By C. A. Hechmer. Pp. 459-461.

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November
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56. Detroit's Answer to a 30-Year Pollution Problem. By G. R. Thompson and A. B. Morrill. Pp. 533-552.

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November
5. Problems and Trends in Activated Sludge Practice. By R. T. Regester. Pp. 1501-1525.

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October
13. Disposal of Mixed Refuse by Sanitary Fill Method at San Francisco, Calif. By J. J. Casey. Pp. 590-592.

M *Canadian Engineer*
October 24
2. p. Trends in Primary Sewage Treatment. By D. L. McLean. Pp. 18, 20, 22.
3. p. Modern Trends in Sewage Treatment. By J. B. Baty. Pp. 24, 26, 28, 30, 32.
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November 14
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November
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Year of 1939
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13. Beneficial Effects of Vocational Training of Sewage Treatment Plant Operators. By J. R. D. Eddy. Pp. 78-82.
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17. Sewage Plant Control Through Reports and Testing. By J. M. Lloyd. Pp. 93-95.
18. A New Type of Sewage Treatment Plant for Texas: (The "Aero-Filter"). By J. C. McVea. Pp. 95-96.
19. A Modern Contact Aeration Sewage Disposal Plant for a Small City. ("Hays process"). By D. Rainey. Pp. 98-102.
20. Sludge Index at the San Antonio Plant. By E. J. M. Berg. Pp. 102-103.
21. Interstate Compact Agreements. By V. M. Ehlers. Pp. 103-105.
22. Controlling Infiltration in Sewer Lines. By H. R. F. Helland. Pp. 106-110.
23. Infiltration in Sewer Lines. By W. F. Hicks. P. 111.
24. Operation of Sewage Pumps and Construction of Pumping Stations. By W. E. White. Pp. 111-115.
25. Sewage Irrigation as a Method of Disposal. By R. L. Peurifoy and R. B. Harrell. Pp. 115-123.
26. Grapefruit Canning Plant Wastes. By H. C. Ratliff. Pp. 123-128.
27. Some Meat Packing Plant Installations for Treatment of Wastes. By G. L. Childress. Pp. 129-133.
28. How a Texas Brewery Handles Its Treatment Problems. By L. A. Godbold and L. Fahr. P. 133.
29. Textile Mill Wastes. By T. E. Craig. Pp. 134-136.
30. Operating Results at Typical Texas Treatment Plants. By G. R. Herzik, Jr. Pp. 136-139.

Information on Plans Not Guaranteed by Specifications

The standard specifications and proposal forms for a city sewer construction contract provided that information obtained from borings made by the city and shown on plans given to bidders was obtained for the city's own use and to enable it to comply with a statute requiring its Bureau of Engineering and Surveys to estimate the cost of the improvement, so that no bid in excess of the estimate should be accepted and that the information was not part of the contract, nor guaranteed correct, and that if a contractor used the information it did so at its own risk. The Pennsylvania Supreme Court held, O'Neill Const. Co. v. Philadelphia, 6 Atl. 2d 525, that the successful contractor could not recover for extra compensation on the ground that it was misled by the city's borings as shown on the plans and encountered submerged timber not disclosed thereon, necessitating work not contemplated when bidding.

Liability for Refilled Trenches

The excavation and refilling of plumbers' ditches before they are permanently repaved are daily occurrences of city life. The municipality's full duty to the public in connection with the temporary repaving of such trenches is not breached so long as the condition is made reasonably safe for travel. The Pennsylvania Supreme Court so holds in Good v. City of Philadelphia, 6 Atl. 2d. 101, absolving the defendant city from liability for injuries to a boy in crossing a refilled water pipe repair ditch in a street which appeared to be even with the rest of the street. Except for faulty construction work on its part, a municipality's liability for defects in the highway arises only when it has notice, actual or constructive, of the existence of a dangerous condition.

Lowest Bidder Provisions

The Massachusetts Supreme Judicial Court says, Slocum v. City of Medford, 18 N. E. 2d 1013, that in the absence of some special provision of law there is no absolute obligation on a municipality to give a contract to the lowest responsible bidder. "There may be reasons leading to an honest belief that it would be safer to entrust the work to one whose bid is somewhat above the lowest. The decision lies in the administrative field and not in the judicial field. The court can interfere only where it is shown that the officer or officers charged with the duty of making the decision have acted corruptly or in bad faith or so unreasonably or arbitrarily as to be guilty of a plain abuse of discretion."

Soil Classification and Testing

Every highway engineer should be familiar with the standard methods of classifying and testing soils, and be able to interpret the results of others even though he does not himself make the tests. The purpose of the following article is to give him the necessary information.

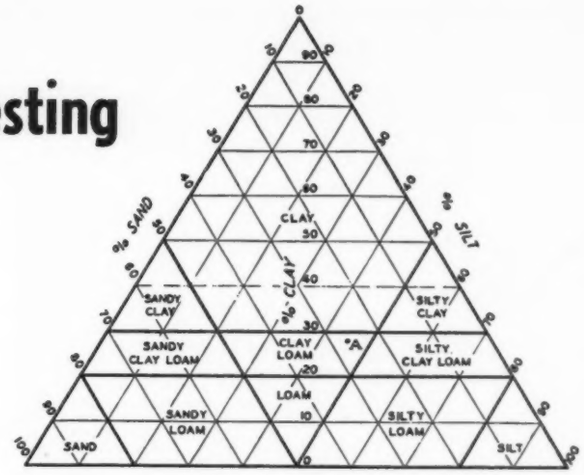
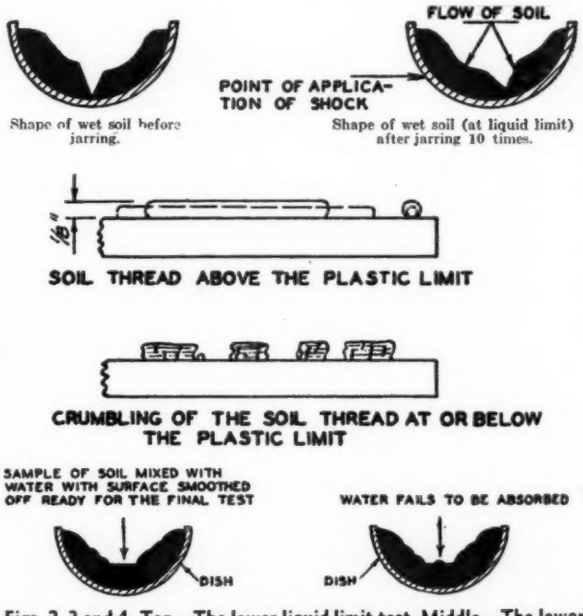


Fig. 1—Chart for textural classification of soils.

FOR purposes of classification, the three types of soil—sand, silt and clay—have been described according to the size of the grain or particle, arbitrary and definite limits of the grain diameter having been adopted. Thus, sand is described as having a grain diameter of not less than 0.05 millimeter nor more than 2 millimeters. If the diameter is less than 0.05 mm., the soil is a silt or a clay, not a sand; and if it is over 2 mm. in diameter, it is gravel. Silts have a grain diameter not more than 0.05 mm., nor less than 0.005 mm. Clays have a grain diameter of less than 0.005 mm., but those clay particles that are smaller in grain diameter than 0.001 mm. are called colloids. In nature, however, these may be mixed in any conceivable proportions; so that we may have a sandy clay, or a silty clay, or any other combination.

In classifying soils by the use of common terms, the following may be employed:

	% sand	% silt	% clay
Sand	80-100	0-20	0-20
Sandy loam	50-80	0-50	0-15
Sandy clay loam	50-80	0-30	20-30
Sandy clay	50-70	0-20	30-50
Silt	0-20	20-100	0-20
Silty loam	0-50	50-80	0-20
Silty clay loam	0-30	50-80	20-30
Silty clay	0-20	50-70	30-50
Clay	0-50	0-50	30-100
Clay loam	20-50	20-50	20-30
Loam	30-50	30-50	0-20



Figs. 2, 3 and 4. Top—The lower liquid limit test. Middle—The lower plastic limit test. Bottom—The field moisture equivalent test.

This table also shows how inadequate such terms as these are to describe soils. For instance, a sandy loam may be 80% sand and 20% clay or silt, or 50% sand and 50% silt, which is also called silty loam. But a silty loam may also contain 80% of silt and 20% of clay. The chart, Fig. 1, shows the mechanical grading of the various designations of soil materials.

Properties of Soils.—The stability of a soil depends upon two factors—the internal friction and the cohesion. Internal friction is increased by the presence of rough, sharp particles, such as are found in sand. Therefore, sand has a high internal friction, while clay, which is composed of smooth, scaly and minute particles, has almost no internal friction. Cohesion is the ability of the soil particles to stick together. Sand has no appreciable cohesion, but clay is highly cohesive.

Cohesion is due to more than one cause, as a rule. The clay particles are very small and fit very closely together, whereas the comparatively large and rough sand particles do not. This very close contact probably produces in the absence of air a true cohesion between the soil particles. Also, very thin films of moisture act as a powerful binding force. On the small clay particles, such very thin moisture films are formed. When two clay particles are pushed together, the thin moisture film acts as a binding agent, holding the particles together. But too much water acts as a lubricant between the grains. Perfectly dry clay particles will not cohere because air films surround the particles, and prevent a really close contact; but if the soil sample is put in a vacuum and the air removed, true cohesion can be obtained.

Volume changes of soil are indicated by shrinkage, swell, compressibility and elasticity. Shrinkage is much greater in clay soils than in sand, because of the smaller size of the particles. As the water evaporates from the surface of the grains, these are drawn closer together. As water is added again, the volume may increase or swell. Sand, with large grains and large pores or openings, does not shrink appreciably as it loses water, nor swell as it takes up water. But clays have a high shrinkage and a high swell.

Compressibility is the decrease in volume resulting from pressure, which causes a reduction in voids. The coarse, rough-grained sand particles are only slightly compressible, unless they contain an excess of water, which is quickly forced out with immediate reduction in volume; but the scaly-shaped clay particles permit compression through rearrangement to fill the voids in the soil. Thus sand is low in compressibility and clay is high.

Elasticity is the ability of a soil to return to its original volume after the force of compression has been released. Sand has little or no elasticity; some clays are relatively high in elasticity.

Water movement in a soil depends on its capillarity and its permeability. Capillarity is the ability to transmit water in a finely divided state in any or all directions, even against the force of gravity. Thus, capillarity can raise water, 5, 10 or even 20 feet upward, through the soil, provided that soil is of the proper texture. The size of the pores or openings between the soil particles affects the capillarity. In general, the smaller the pore or opening, the higher will water be raised, but the slower will be the rate of flow. Thus sands have small capillary power; silts more; clays most.

Permeability is really a measure of the drainability of soil. With its comparatively large soil particles and pore openings, sand is highly permeable, but clays are relatively impermeable as they retain water, yielding it slowly.

Plasticity is the capacity of a soil to undergo a change of shape which may involve a complete rearrangement of the soil particles without a noticeable change in volume. Changes of shape in sands cause a measurable change in volume; but clays, when wet or plastic, can undergo changes in shape, even involving a complete rearrangement of particles, with no appreciable change in volume.

The above comparisons are made between sand and clay. Silt, as a rule, falls between the other two in regard to all of the characteristics mentioned.

Tests for Soil Constants

There are certain standard tests which, by their results, indicate certain basic physical properties of the soils. The values obtained by these tests, when considered in their relation to each other, serve not only to identfy the soil, but also to predict what it will do under actual construction conditions.

Lower Liquid Limit

This is a standardized test for determining the least amount of moisture a soil must contain for it to pass into a liquid state. The soil passes into a liquid state when enough water is added to fill the voids in the soil and also to surround each soil particle with a film of moisture so that the soil will "flow," that is, change from the solid to the liquid state. The lower liquid limit is that moisture content, expressed as a percentage of weight of the completely dried soil, at which the soil will just begin to flow when jarred ten times.

The soil is mixed with water, placed in a porcelain evaporation dish about 4½ ins. in diameter, shaped into a smooth pat or layer about ⅜ ins. thick in the center, and divided by means of a grooving tool to the form shown in (a) Fig. 2. The dish is then held firmly in one hand and tapped lightly ten times against the palm of the other hand. This procedure is repeated, increasing (or decreasing) the added water, until a moisture content is reached where the two edges exactly

meet, after ten taps, as shown in (b), Fig. 2. Then a small quantity of the soil from that portion which has flowed during the tapping process, is taken up, placed in another container, weighed, dried and weighed again.

The container should be weighed before the wet soil is placed in it; again with the wet soil in it; and finally after thorough drying in an oven has removed all moisture. Thus:

Weight of dish 150 grams without soil
Weight of dish 210 grams with wet soil
Then weight of wet soil is 60 grams
Weight of soil after drying 42 grms
Added water is 18 grams; 18 ÷ 42 = 43, L.L.L.

Sands have low liquid limits—generally around 20; clays are much higher—about 100. Silt may range up to 30. If values exceed 100, there probably are diatoms, mica flakes, colloids (which are very finely divided clays) or peats present.

Lower Plastic Limit

The test for lower plastic limit is a standardized procedure for determining the lowest moisture content at which the soil can be rolled into threads ⅛ in. in diameter without the threads breaking. See Fig. 3.

Procedure in this test consists of adding water to the soil and rolling it into threads ⅛ in. in diameter between the palm of the hand and a ground glass plate. If the thread rolls out to the desired size without crumbling, too much water has been added, and another trial should be made using less moisture. For the purpose of the test, the soil thread should begin to crumble or break into sections as it reaches the desired size. A sample should then be placed in a previously weighed container, weighed with the container, dried in an oven and again weighed. The lower plastic limit is the per cent of moisture in the soil.

Sand has no plasticity. No matter how much or how little water is added, it cannot be rolled into threads. The same is true of mica, diatoms and peat. These materials therefore have no plastic limit. The lower plastic limit for silt will usually be around 20, for clay and colloids around 45, and for mixtures at intermediate figures.

The two preceding tests have shown the lower limit at which the soil is plastic and also the lower limit at which it is liquid. This lower liquid limit might also be called the upper pastic limit. The Plasticity Index is the range of moisture content through which the soil is plastic, or the difference between the lower liquid limit and the lower plastic limit.

If the lower liquid limit is 50, and the lower plastic limit is 20, the plasticity index is 50—20=30. A soil having as high a plasticity index as this would be highly plastic. Plasticity index for sand is 0.

Shrinkage Limit

Some soils, when they dry out, shrink or decrease markedly in volume, until a certain point is reached, beyond which the loss of water does not reduce the volume further. The moisture content of the soil at which any further reduction in moisture will not cause a further decrease in volume of the soil is the shrinkage limit.

The shrinkage of soils, and also their swell or expansive ability, are important in highway work. Not only may cracks occur in the subgrade or foundation; but also if soils shrink as they dry out, they will also swell as they absorb more moisture, possibly causing heaving.

In making the test, a dish is filled with the soil to be

tested. That portion of soil passing a No. 40 sieve should be used and the moisture content of the soil should equal or just exceed the liquid limit of the soil. The soil is then dried until it has attained complete shrinkage, and drying is continued until it is completely dry. The shrinkage is then measured by immersing the soil pat in a dish exactly filled with mercury. The pat displaces its own volume of mercury which overflows and is caught in a surrounding dish and measured.

The loss in volume during shrinkage is caused by and is in proportion to the amount of water lost. The ratio of volume change to moisture loss is the "Shrinkage ratio" and is equal to the bulk specific gravity of the soil.

Centrifuge Moisture Equivalent

This test is a measure of the permeability of the soil. Dry soil passing the No. 40 sieve is placed in a crucible which is placed in a pan of water and allowed to absorb water for 6 hours. It is then allowed to drain in a humidifier for 12 hours, and finally whirled in a centrifuge for 1 hour at a speed which results in a force 1000 times gravity acting on the soil. The percentage of moisture in and on the soil after centrifuging is the centrifuge moisture equivalent.

Sands and other porous soils will have a low centrifuge moisture equivalent, indicating drainability and a low retention of capillary moisture. A high centrifuge moisture equivalent indicates an impervious and undrainable soil. In some impervious soils, "water logging" occurs during centrifuging, that is, a part of the water is forced to the top of the sample and retained there.

Field Moisture Equivalent

The field moisture equivalent is the maximum percent of moisture that a soil will absorb under ordinary field conditions, when not compacted. It is the moisture content that the soil is apt to absorb under natural conditions. Therefore if this test indicates water is absorbed in excess of that indicated by the shrinkage limit test, it is an indication that the soil is likely to expand during wet periods, and is therefore unsuited for certain highway uses. Highly expansive clays have field moisture values considerably in excess of their shrinkage limits.

In making this test, a soil sample is mixed with water and spread out on a dish, a section of the surface is smoothed off and water is dropped onto the smooth surface (drop by drop) until it is no longer absorbed by the soil, but spreads out to form a shiny water film on the surface. See Fig. 4.

The sample, or a portion of it is then weighted, oven-dried to constant weight at 110°C and weighed. The loss in weight due to drying is recorded as the weight of water. The field moisture equivalent is 100 times the weight of water divided by the weight of the dried soil.

Mechanical Analysis

A mechanical analysis of soils shows the size and grading of the soil particles but is far from a complete identification of the character of the soil as it will perform on the highway. In making the test, the soil is passed through a series of sieves, and the amount retained on the various sieves is weighed and recorded. The size of the soil particles that pass a 200 sieve is determined by a hydrometer analysis. This is based on the fact that particles settle in water at a rate that is proportional to the size of the particle—the specific

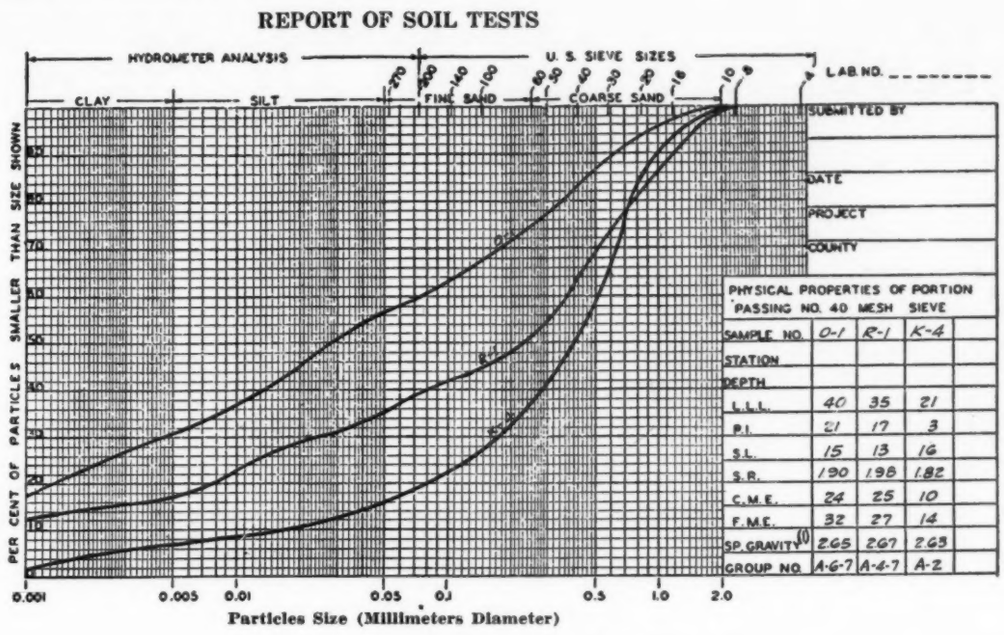


Fig. 5—Results of mechanical analysis of three Kansas soils

gravity of the particles being equal. The soil particles passing the 200 sieve are made into a suspension and the density of this suspension in terms of grains of soil in suspension per liter is computed from the readings of a special hydrometer.

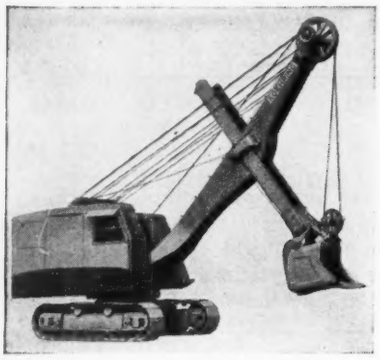
On Fig. 5 are plotted the results of a mechanical analysis of three Kansas soils of favorable gradation. Other properties of the soils are shown in the lower right corner, covering lower liquid limit, plasticity index, shrinkage limit, shrinkage ratio, centrifuge moisture equivalent, field moisture equivalent, specific gravity and grouping of soil classification. In this chart, the volumes of the portions between the 10 mesh or 2 mm particle diameter and the 200 sieve (about 0.075 mm particle diameter) were made by passing the soil through sieves. Below the 200 sieve, the size of the particles was obtained by hydrometer analysis.

When you need special information—consult the *classified* READER'S SERVICE DEPT., pages 56 to 58.

Keeping Up With New Equipment

Koehring 1½-Yard Shovel Has Many Improvements

The Koehring 604 excavator is described fully in a new catalog issued by Koehring Co., Milwaukee, Wisc. This is a machine of completely new design, using more high strength steels and welded construction. Lower maintenance

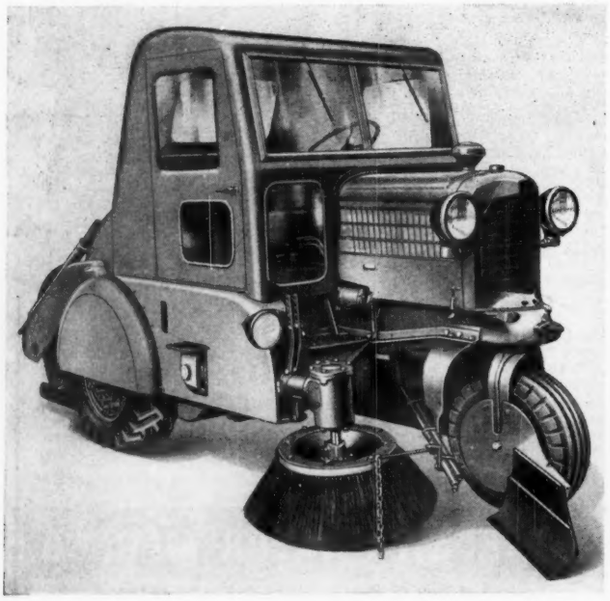


Koehring 604, 1½-Yard Shovel

should result from forced flood lubrication and anti-friction bearings. The machine is quickly convertible to dragline or crane.

Enclosed Cab for A-W Patrol Sweeper Comfort

The Patrol Sweeper made by Austin-Western Road Machinery Co., Aurora, Ill., can now be equipped with a streamlined, enclosed cab. This gives protection and comfort to the operator under any weather conditions, without impairing visibility; in fact better visibility is claimed than is found in the usual automobile.



Austin-Western Sweeper With Enclosed Cab

The Improved Brooks "Load Lugger"

Brooks Load Lugger Still Further Improved

A new model of the Brooks "load lugger" has been developed, which is said to have better load distribution, a simpler hoisting mechanism and simplified control. This device is of especial interest and value to city and county officials, as it is one of the few really economical units for small dirt-moving operations. It permits one truck to handle 5 to 10 buckets; not only is waiting truck time saved, but men can work all the time without waiting for trucks to unload, return and maneuver into position.

New Tamping Rollers and Rippers by Bucyrus-Erie

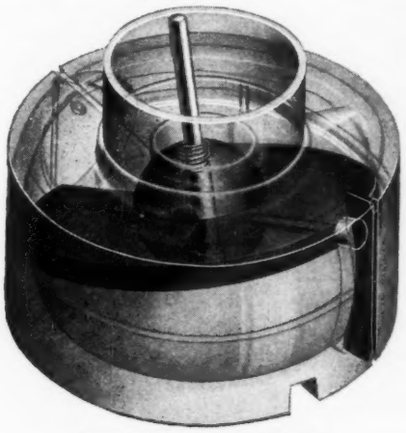
The new B-E tamping rollers are single, double or triple drum units, with 72, 96 or 112 feet per drum. All rollers have rear pull connections for working in trains; double and triple models have oscillating drums to permit the rollers to work properly on uneven surfaces. Tamping feet are renewable. See catalogs for further details.

The new rippers are built in both rotary and heavy-duty cable operated types. The rotary units are especially effective in ground that contains boulders and heavy roots. The cable control units are for shale, hardpan, sandstone, old macadam, etc. These will cut 17 to 24 inches deep, depending on the model. Full information in bulletins from Bucyrus-Erie Co., South Milwaukee, Wisc.

New Bucyrus-Erie Units

Trident Water Meters to Have Thrust Roller Bearings

It has been announced by the Neptune Meter Co. that beginning Jan. 1, 1940, a thrust roller bearing plate will be standard in Trident water meter disc chambers. This will prolong the life of the chamber, increase its sensitivity, reduce repair cost and eliminate a possible source of sound. These new chambers may be installed in meters now in service, and old chambers may be returned to the factory to be brought up to date.



New Trident Meter Bearing

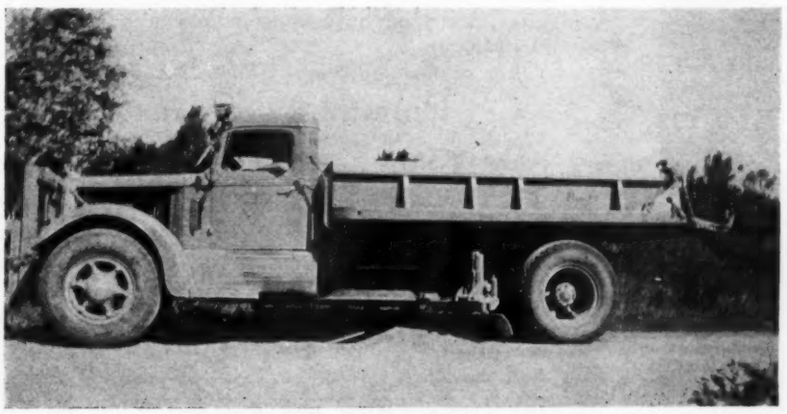
Pittsburgh, Pa., Cuts Off a Mountain Top With the Aid of LeTourneau Carryalls and a Belt Conveyor System. The Leveled Area Will Form the Site of a New Federal Housing Project.

For Planing and Leveling Road Surfaces

Many highways have been so maintained as to allow shoulders to become elevated above the road surface, interfering with the proper drainage. This high shoulder unsually consists of sod. The new Root Model F-3 scraper, with full height moldboard, makes it possible to correct this condition easily at a rapid rate. It is also adapted to planing and leveling road surfaces before the final application of bituminous materials. For this work the spring cushion is blocked so the blade is held rigid in any position, offering a perfect planing action.

Snow and ice may be removed readily by locking the springs. It must be remembered, however, that the planing and leveling of hard gravel roads, and the removal of packed snow and ice require a tremendous pressure. The transmission operated hydraulic pump generates four times the normal operating pressure.

On regular speed maintenance of gravel highways, the adjustable spring cushion is very important. Easy adjustment of cushion is something new and necessary as various types of road surfaces require a different spring tension.



Root Scraper for Road Planing and Leveling

Curing Concrete Pavements with Calcium Chloride

A brief report of tests by the Public Roads Administration (formerly Bureau of Public Roads) on the use of calcium chloride, applied to the surface of the concrete for curing, has been made available by the Calcium Chloride Association, Detroit, Mich., and will be sent on request.

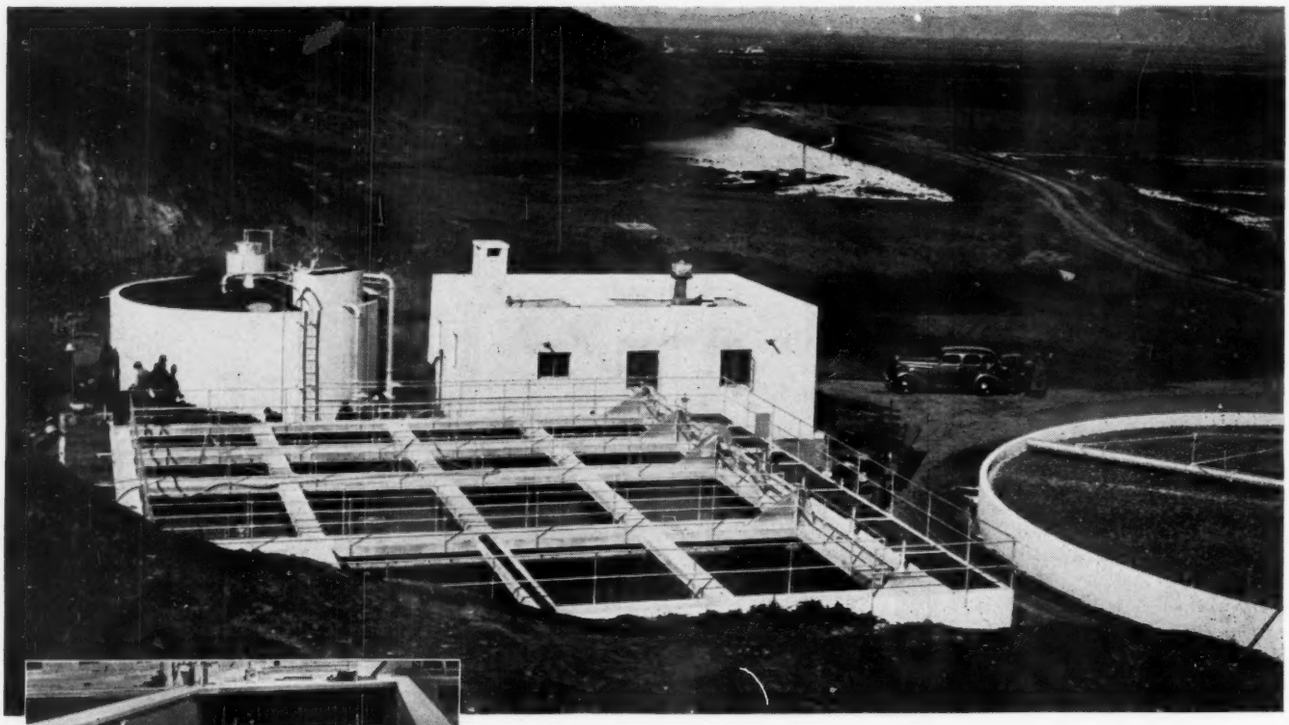
A Service Pipe Puller That Saves Digging

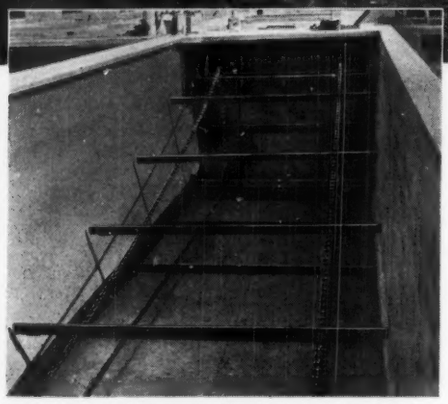
This is a specially designed "puller" unit, which simplifies removal of service pipes and their renewal by eliminating cosly digging. Only a short section of trench need be opened, and damage to lawns, streets and walks is reduced. One unit handles 1", 1¼" and 1½" pipe. Bulletin U-40 describes the unit. Templeton, Kenly & Co., 1020 South Central Ave., Chicago, Ill.

How the "Pipe Puller" Works

A Repeat Cycle Timer

This device is designed to use on AC circuits to (a) alternately close and open one or two circuits continuously at any preset operating interval; and (b) to close or open a single circuit after any preset operating interval and stop, ready to repeat its cycle upon reclosure of a starting switch. A variety of time ranges is available. Full information from R. W. Cramer Co., Inc., Centerbrook, Conn.





Link-Belt STRAIGHTLINE *Sludge Collector*

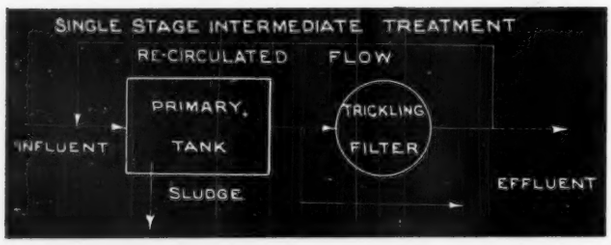
Biofiltration Sewage Treatment System with LINK-BELT STRAIGHTLINE COLLECTORS Brings New Advantages

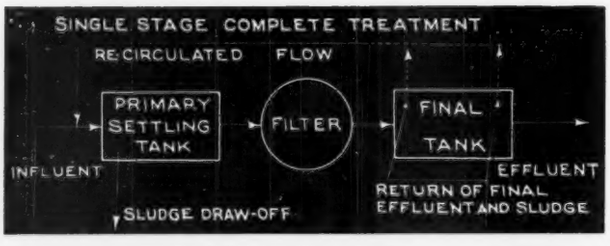
● This system, which consists of a combination of high-rate filtration and the re-circulation of the effluent from sprinkling filters back to the primary settling tanks, assures the exact degree of purification desired. It is recommended for new plants where better than primary effluents are required and for existing trickling filter or activated sludge plants which are overloaded.

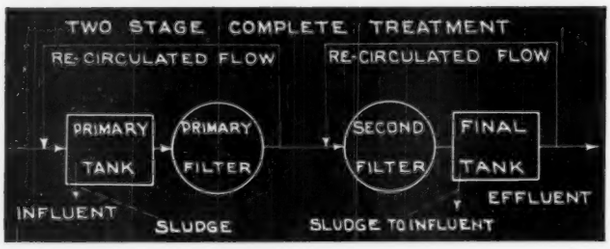
Single-stage treatment is satisfactory for average requirements, but where a higher degree of purification is essential or where strong sewage or industrial waste is handled, the two-stage system is recommended.

The Camarillo, Calif., State Hospital sewage treatment plant, illustrated above, employs this system in single-stage. The four horizontal settling tanks shown in the foreground, are equipped with Link-Belt STRAIGHTLINE Collectors for the continuous or periodic removal of sludge and scum.

Let us tell you more about this system.







LINK-BELT COMPANY 7906

Philadelphia Chicago Los Angeles Indianapolis
Cleveland Atlanta Toronto Offices in Principal Cities

LINK-BELT
SEWAGE TREATMENT AND WATER PURIFICATION PLANT EQUIPMENT

When you need special information—consult the *classified* READER'S SERVICE DEPT., pages 56 to 58.

Multi-Stage Slo-Mixing by Chain Belt

The Langelier process of multi-stage flocculation or slow mixing is now incorporated in Chain Belt water and sewage mixing basins. In this device, either the paddle speed or the paddle area, or both, are progressively decreased; paddles are installed with direction of rotation at right angles to the flow of liquid. A variety of drives are available, and these mixers may be installed in existing basins and plants, or in new ones. Full information from Chain Belt Co., Milwaukee, Wis.

Sludge Dewatering

A new folder on filtration equipment has been issued by Goslin-Birmingham Mfg. Co., Birmingham, Ala., featuring the Conkey vacuum filter, the Conkey vacuum dewaterer, and the Birmingham rotary vacuum filters. Sent on request.

Gibbons Plan End Pipe Fittings

Here is a coupling for plain end pipe that should be of value to many responsible for piping for water, gas, sewage or other liquids. The coupling is threadless, the principal features being shown in the illustration herewith. The only tools necessary are a pipe cutter, hammer and wrench. Folder sent on request. Gibbons Mfg. Co., 69 Hammond St., Worcester, Mass.

Low Cost Tractor Can Do Many Jobs

A four-wheel, pneumatic tired tractor is suited for many light jobs — highway maintenance, parks, airports, street sweeping and snow plowing. Allis-Chalmers Mfg. Co., Milwaukee, Wisc., has brought out the Model "IB" 13.5-18 hp., which weighs 2,140 pounds. It is short and compact, and easily handled.

4-Wheel, Light A-C Tractor

Fuel consumption is said to be less than 1 gallon per hour. Fuller data from the manufacturer.

Blue Print Machine with High Pressure Mercury Quartz Lamp

This new type blue print machine has been announced by Charles Bruning Co., Inc., 100 Reade St., N. Y. In addition to the new light, which is listed

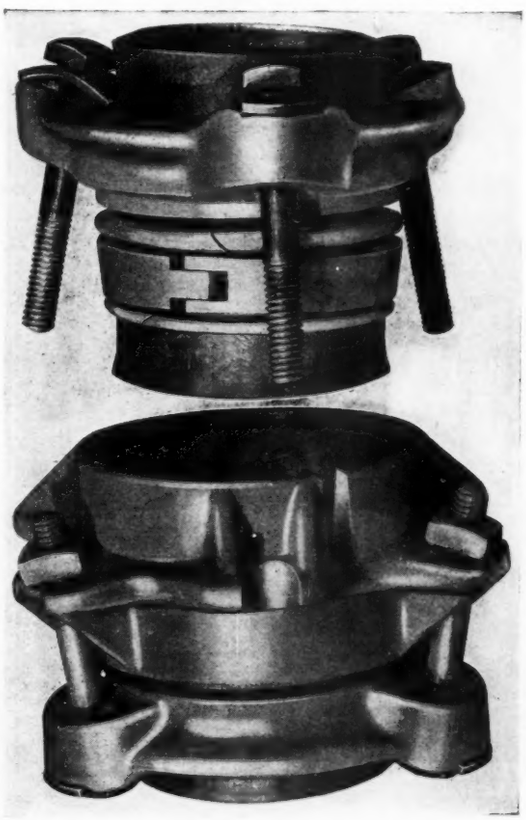
Bruning "Blue-Printer"

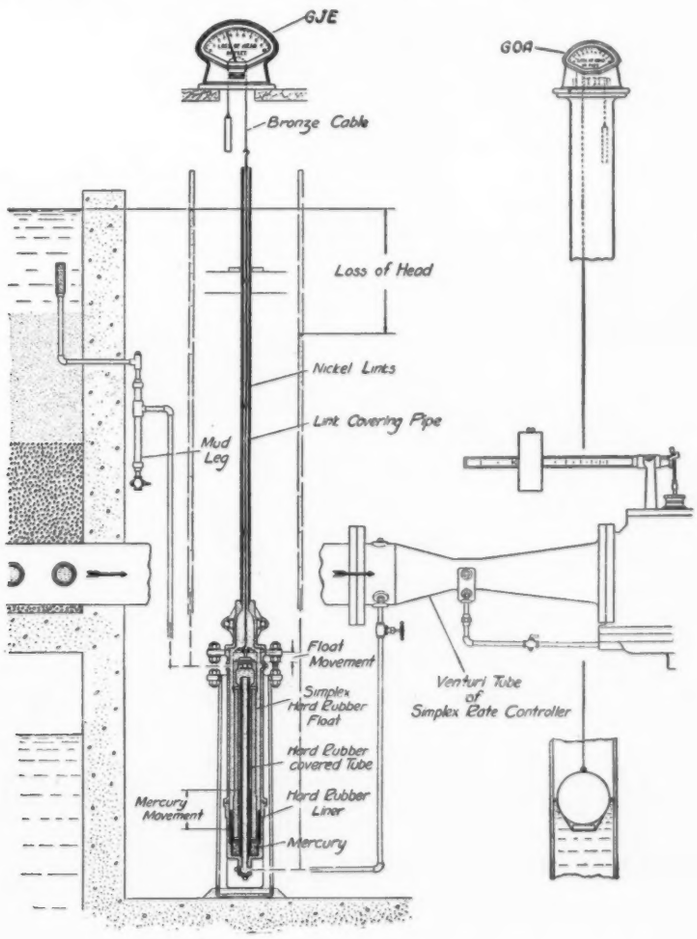
as a major improvement, giving positive, uniform, non-flickering light distribution, other devices assure high speed, easy control and improved printing.

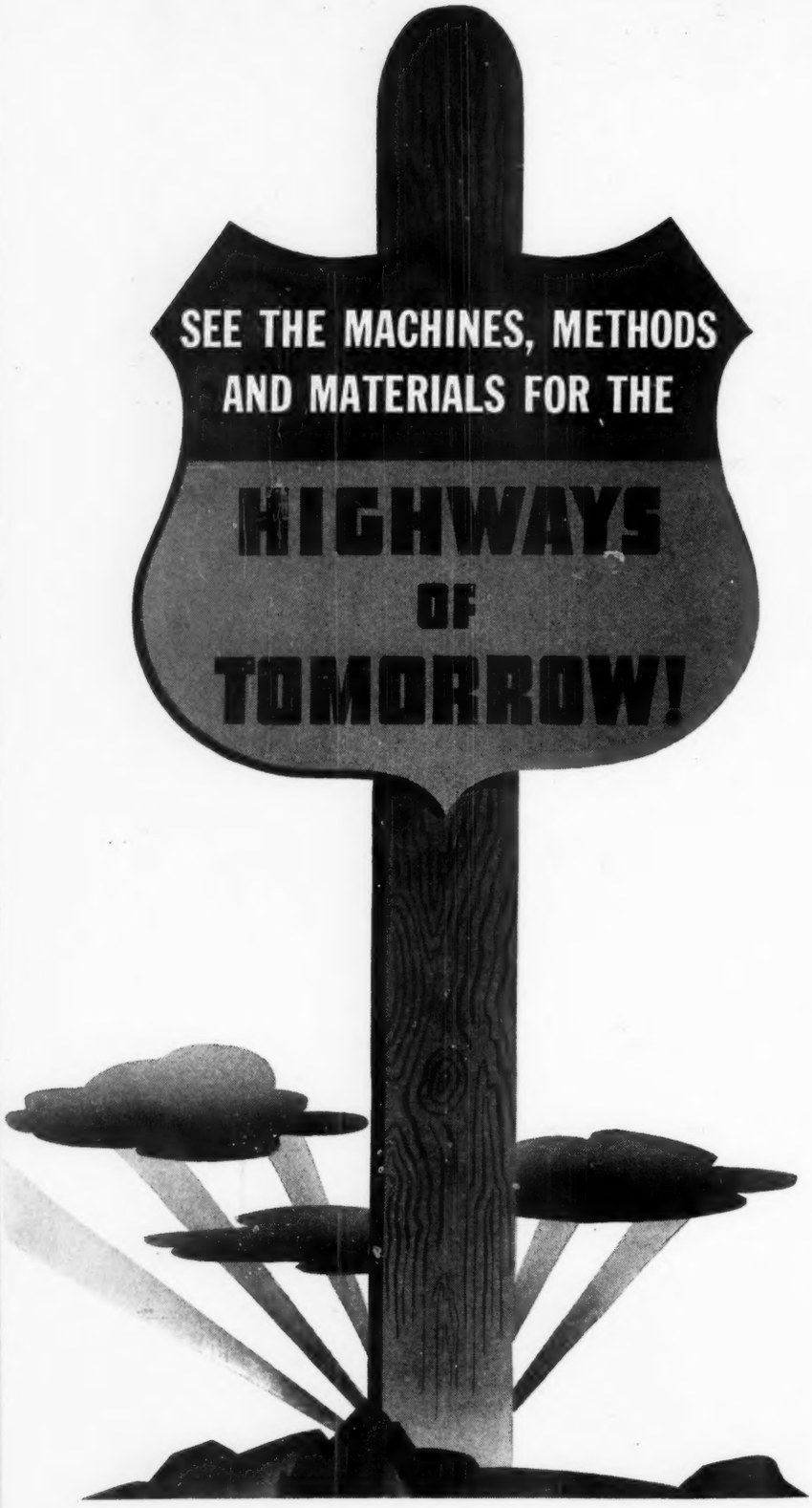
Gauges for Water Purification and Control

A new booklet on "Gauges" has been issued by Simplex Valve & Meter Co., 6750 Upland St., Philadelphia, Pa. It describes and illustrates with excellent drawings the uses and installation of various gauges, including loss of head, rate of flow, elevation, etc. Bulletin No. 78. The illustration herewith shows at the left a differential type loss of head gauge and at the right a non-differential type of lower first cost.

At Right: Simplex Rate Controller for a Rapid Sand Filter. Below: Gibbons Plain End Pipe Fittings.







CONTRACTORS! Engineers! State and County Highway Officials! Here's your chance to see, compare and evaluate for yourself every recent development in the long line of machines, methods and materials you use on your jobs!

That's right, the A. R. B. A. Road Show and Convention is a grand opportunity to get off to the right start in 1940—to get together with the men who know your problems; to talk shop with old friends and make new ones; to get a line on how your business is going to shape up in 1940! Make no mistake—you're giving yourself a break when you plan to attend the 1940 A. R. B. A. Road Show in Chicago on January 29 to February 2.

COME TO THE 1940 A. R. B. A. ROAD SHOW AND CONVENTION

International Amphitheatre • Chicago • January 29 to February 2

Dowax Protection for Better Trees and Shrubs

A wax emulsion containing bentonite has been developed by Dr. E. J. Miller of the Michigan State Experiment Station. When applied to trees and shrubs, this prevents excessive evaporation. It is of especial value before or at the time of transplanting, and it also reduces winter injury on evergreens. The concentrated material is diluted and sprayed on the tree or shrubs. It is manufactured by the Dow Chemical Co., Midland, Mich.

Anti-Freeze for Compressed Air Lines

Protection to 70 below zero is provided by anti-freeze systems developed by Sullivan Machinery Co., Michigan City, Ind. Bulletin R-16 contains full descriptions of Tannergas, Frosto and the newly developed Frosto vaporizer for portable compressors.

Whiting to Ozonate Water Supply

Construction work is now under way in Whiting, Ind., and ozonation equipment, which will have a daily capacity of 45 pounds of ozone is being installed. About 3 million gallons of water daily will be treated. The plant is expected to be in operation early in 1940.

Power Pump for Hydraulic Controls

Hydraulic controls for snow plows, highway maintenance and construction machinery and other construction equipment has many advantages. This new pump by Monarch Road Machinery Co., Grand Rapids, Mich., is designed for average working conditions. It may be installed on any truck or tractor. Power is from the fan belt. Only two or three hours are required for installation.

What AWWA Convention Attendance Means

The Industrial Chemical Sales Division, West Virginia Pulp and Paper Co., is offering prizes for the three best papers submitted on the topic "What attendance at the annual meetings of the A.W.W.A. has meant to me." First prize is $50; second prize $25; third prize $10. Papers should not exceed 250 words in length; prizes will be awarded by a jury of three men well known in the water works field. The closing date is Dec. 31, 1939. Send your entry to Contest Editor, Taste & Odor Control Journal, Industrial Chemical Sales Division, 230 Park Ave., New York.

Interned German Sailors Have Safe Water Supply

"Safekeeping" of the German prize crew whom the Norwegian government recently interned after returning the steamship "City of Flint" to its American owners, even extends to providing a safe water supply, according to Proportioneers, Inc., of Providence, R. I. H. E. Hollberg of the firm's European office reports that a factor in choosing the old fortress at Kongsvinger, Norway, was the town's modern waterworks plant. Designed by Wetlesen and Roll, engineers, the system includes four mechanical feeders, two feeding saturated lime water, one each alum and hypochlorite. All are controlled by meters installed in the influent line. The water treated is from bog lake sources, heavily impregnated with iron. Normal capacity of the plant is 600,000 gpd.

New Appointments

The following new appointments have been reported by our readers:

George F. Hughes, Supt. Water Works, Denver, Colo.

George Cobb, Chief Engineer, Dept. Public Works, Baltimore, Md.

W. A. Parranto, Supt. Water Works, St. Paul, Minn.

G. E. Carlson, Mower Co. Engineer, Austin, Minn.

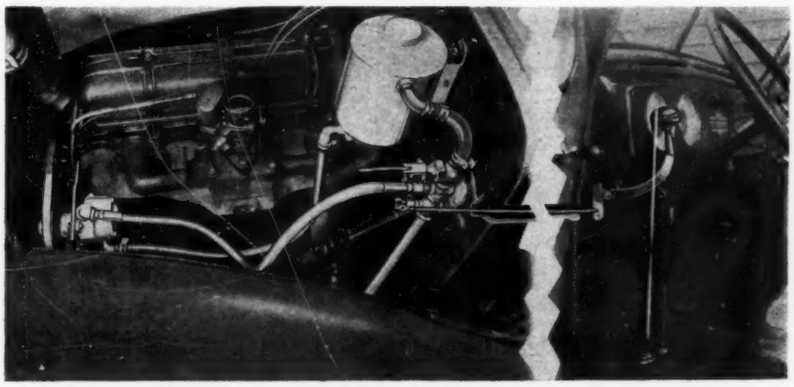
Ray Lynch, City Engineer, Pawhuska, Okla.

G. R. Henderson, Harrison Co. Engineer, Marshall, Tex.

P. W. Smith, City Engineer, St. Peter, Minn.

J. C. Hanley, City Engineer, St. Louis, Mich.

W. D. Edwards, City Engineer, Ruston. Ia.



New pump taking power from fan belt. Monarch Road Machinery Co.

Harry Mundhenke has been appointed City Engineer of Rockford, Ill, succeeding the late Mogens Ipsen.

E. N. Fletcher, City Engineer, Des Plaines, Ill.

R. W. Neynion, City Engineer, Wallace, Idaho.

J. R. Rogers, City Engineer, Lavonia, Ga.

J. W. Steed, City Engineer, Fairburn, Ga.

J. W. Phelps, Boro Engineer, Branford, Conn.

Cyrus Clevenger, City Engineer, Columbus, Ind.

Robert T. Regester has opened an office for the practice of sanitary engineering in the Baltimore Life Bldg., Baltimore, Md.

George F. Schlesinger, chief engineer and secretary of the National Paving Brick Association, Washington, D. C., died suddenly, Dec. 1. Mr. Schlesinger was well known in engineering and road-building circles throughout the nation. Since September, 1938, he had served as treasurer of the American Road Builders' Association. He was graduated from the Ohio State university as a civil engineer in 1907. In 1919, he became division engineer of the Ohio State Highway Department and was appointed director of the state department of highways and public works in 1925. He resigned this office in 1928 to accept the post with the National Paving Brick Association, which he held until his death.

Readers' Service Department

Help Yourself to These Helpful Booklets

These booklets are FREE. Use the coupon or write the manufacturer direct, mentioning PUBLIC WORKS.

Construction Materials and Equipment

Air Compressor from Ford Parts

5. How you can convert an ordinary Ford model A or B motor into an air compressor for operating jackhammers, paving breakers, clay spaders, tampers, paint sprays, etc., is explained in a new bulletin just issued by Gordon Smith & Co., Desk G, 516—10th St., Bowling Green, Ky.

Cold Mix Plants

10. New catalog and prices of Portable Bituminous Mixers in 6 to 14 ft. sizes for resurfacing and maintenance. Issued by The Jaeger Machine Co., 400 Dublin Ave., Columbus, Ohio.

Concrete Accelerators

30. "How to Cure Concrete," a forty-seven page manual published by the Dow Chemical Company, Midland, Michigan, treats fully subject suggested by title.

31. New 48-page booklet in five sections explains clearly the effects, advantages and methods of using Calcium Chloride and Portland Cement mixes. Complete and packed with practical information; well illustrated; pocket size. Sent free on request by Solvay Sales Corp., 40 Rector St., New York, N. Y.

36. "Wyandotte Calcium Chloride and its use in Portland Cement Concrete," a booklet covering the subject of curing concrete pavements, structures, etc., giving complete specifications for surface and integral curing. Published by the Michigan Alkali Co., 60 East 42d St., New York, N. Y.

Dirt Moving Efficiency

65. "Dirt Moving," is a new 32 page booklet illustrating the use of Trac Tractors as a source of money-making power for bulldozers, bullgraders, wheel scrapers, fresnos, graders, dump wagons, tampers, etc. 24 pages of action pictures, directions, etc. Sent promptly by Internaional Harvester Co., 180 No. Michigan Ave., Chicago, Ill.

Drainage Products

70. Standard corrugated pipe, perforated pipe and MULTI PLATE pipe and arches—for culverts, sewers, subdrains, cattlepasses and other uses are described in a 48-page catalog entitled "ARMCO Drainage Products," issued by the Armco Drainage Products Association, Middletown, Ohio, and its associated member companies. Ask for Catalog No. 12.

Hose and Belting

87. Complete information on rubber hose and belting for all types of contracting and road building service. The Government Sales Department of the Goodyear Tire & Rubber Co., Inc., Akron, Ohio.

Melting Kettles, Bituminous

92. Bulletin 182W on the new HEET-MASTER melting kettle, the new way to heat tar, pitch, asphalt and other bituminous materials with a saving of 50% on fuel and a like saving on time, has been issued by the AEROIL BURNER CO., INC. of West New York, N. J.

Mud-Jack Method

107. How the Mud-Jack Method for raising concrete curb, gutter, walls and street solves problems of that kind quickly and economically without the usual cost of time-consuming reconstruction activities—a new bulletin by Koehring Company, 3026 West Concordia Ave., Milwaukee, Wis.

Paving Materials, Bituminous

111. An excellent booklet issued by The Barrett Co., 40 Rector St., New York, N. Y., describes and illustrates the uses of each grade of Tarvia and Tarvialithic; 32 good illustrations.

Paving Materials, Gutters

119. "Brick Gutters and Parking Strips." A study dealing with the problems faced in the proper construction of gutters and how they can be overcome.

Pumps

121. New illustrated catalog and prices of Jaeger Sure Prime Pumps, 2" to 10" sizes, 7000 to 220,000 G.P.H. capacities, also Jetting, Caisson, Road Pumps, recently issued by The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

123. New brochure by Gorman-Rupp Co., Mansfield, Ohio, illustrates and describes many of the pumps in their complete line. Covers heavy duty and standard duty self-priming centrifugals, jetting pumps, well point pumps, triplex road pumps and the lightweight pumps.

Retaining Walls

126. Charts showing the design of cellular or bin-type metal retaining walls, helpful suggestions on their use for stabilizing slopes, preventing stream encroachment, and solving problems of limited right of way, and construction details are given in a 16-page bulletin entitled, "ARMCO Bin-Type Retaining Walls." It is published by the Armco Drainage Products Association, Middletown, Ohio, and member companies. Ask for Bulletin H-37.

Road Building and Maintenace

127. See road work as it was done in the 1890's and as it can be done by a full line of this year's road building equipment. See, in this new action picture book, the first reversible roller, 1893 World's Fair Award Grader and how methods have changed. Attractive new booklet AD-1796 recently issued by The Austin-Western Road Machinery Co., Aurora, Ill.

128. Motor Patrol Graders for road maintenance, road widening and road building, a complete line offering choice of weight, power, final drive and special equipment to exactly fit the job. Action pictures and full details are in catalog 200 issued by Galion Iron Works & Mfg. Co., Galion, Ohio.

Rollers

130. New bulletin describing in detail the new Huber Road Rollers will be sent promptly on request by the Huber Mfg. Co., Marion, Ohio.

132. "The Buffalo-Springfield line of road rollers (tandem, 3-wheel, and 3-axle) are described in the latest catalog issued by the Buffalo-Springfield Roller Co., Springfield, Ohio."

133. New Tu-Ton roller of simple construction for use in rolling sidewalks along highways, playgrounds and other types of light rolling is fully described in a bulletin issued by C. H. & E. Mfg. Co., 3846 No. Palmer St., Milwaukee, Wis.

Shovels, Cranes and Excavators

145. The Austin-Western-Badger, a fully convertible ½ yard crawler shovel, made by The Austin-Western Road Machinery Co., No. A-5 Aurora, Ill., is fully described and illustrated in their Bulletin No. AD-1683.

146. New catalog picturing the detailed construction of Osgood "Chief" power shovel and illustrating it as shovel, clamshell, dragline, crane and piledriver. Write The Osgood Co., Marion, Ohio, for your copy.

Spreader

147. Jaeger Paving equipment, including Mix-in-Place Roadbuilders, Bituminous Pavers, Concrete Bituminous Finishers, Adjustable Spreaders, Forms, etc.—4 complete catalogs of latest equipment in one cover, issued by The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

Soil Stabilization

152. The Columbia Alkali Corporation, Barberton, Ohio, will be glad to furnish to anyone interested complete information dealing with Calcium Chloride Stabilized Roads. This literature contains many charts, tables and useful information

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(Continued from page 56)

Readers' Service Department

and can be obtained by writing The Columbia Alkali Corporation, Barberton, Ohio.

154. "Soil Stabilization with Tarvia"—An illustrated booklet describing the steps in the stabilization of roadway soil with Tarvia will be mailed on request by The Barrett Company, 40 Rector St., New York, N Y.

155. **"Better Bases for Better Roads"** is a useful new booklet describing and illustrating the use of calcium chloride stabilized graded aggregate mixtures for pavement bases. Sent on request by Solvay Sales Corp., 40 Rector St., New York, N. Y.

Street and Paving Maintenance

Asphalt Heaters

198. Illustrated Bulletins 15 to 20 describe Mohawk Oil Burning Torches; "Hotstuf" Tar and Asphalt Heaters; Portable Trailer Tool Boxes; Pouring Pots and other equipment for street and highway maintenance, roofing, pipe coating, water proofing, etc. Mohawk Asphalt Heater Co., Frankfort, N. Y.

Dust Control

210. "How to Maintain Roads with Dowflake" is a new 58 page illustrated booklet of information on stabilized road construction. Includes specifications and several pages of reference tables from an engineer's notebook. Issued by Dow Chemical Co., Midland, Mich.

Sweepers, Rotary

300. "Frink Roto-Broom," a 4 page bulletin illustrating and describing a new rotary sweeper by Frink. Attaches to front of and makes a sweeper of any motor truck. Used by street and highway departments, parks, airports, playgrounds, arenas, coliseums, etc., for sweeping dust, dirt, sand gravel, cinders, leaves or snow. Carl H. Frink, Mfr., Clayton, 1000 Islands, N. Y.

Snow Fighting

Plows

349. "Frink V Type Sno-Plows" is a 24 page catalog fully illustrating and describing 8 models of V Type Sno-Plows for motor trucks from 1½ up to 10 tons capacity, 16 models of Frink Leveling Wings, the Frink Hand Hydraulic Control and the latest Frink Selective Power Hydraulic Control. Data are given for selecting the proper size V plow and wing for any truck. Issued by Carl H. Frink, Mfr., Clayton, 1000 Islands, N. Y.

Spreaders, Sand & Cinder

352. New catalog, 51-A, describes new features of the greatly improved Little Giant sand and cinder spreader that is priced within reach of small as well as large places. Write to Portable Elevator Mfg. Co., Bloomington, Ill.

Winter Heating Equipment for Contractors

353. A bulletin that shows Concrete Heaters, Coil Water Heaters, Salamanders, Ground Thawers, Steam Thawers and other equipment to keep Winter Construction jobs running at Summer Speed despite snow, frost, sleet, ice or cold. Bulletin issued by the Aeroil Burner Co., Inc., of West New York, N. J. Ask for Catalog 168W.

Sanitary Engineering

Anaylsis of Water

360. "Methods of Analyzing Water for Municipal and Industrial Use," is an excellent 94 page booklet with many useful tables and formulas. Sent on request by Solvay Sales Corp., 40 Rector St., New York, N. Y.

Activation and Aeration

375. This concise folder No. 1294 describes "Straightline Aerators" for activated sludge treatment; combines these features: 1, rapid circulation in the tanks; 2, exposure of large surfaces, hastened oxidation and bacteriological growth. Link-Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.

376. A valuable booklet on porous diffuser plates and tubes for sewage treatment plants. Covers permeability, porosity, pore size and pressure loss data, with curves. Also information on installations, with sketches and pictures, specifications, methods of cleaning and studies in permeability. 20pp. illustrated. Sent on request to Norton Company, Worcester, Mass.

Aerators for Sewage

377. New 24 page booklet, No. 6571 describes and illustrates the Dorrco Paddle Aerator and also the Turbo-Aerator. Also contains a discussion of the activated sludge method of treatment with much interesting data and illustrations, including a section of "Useful Information." Issued by The Dorr Co., 570 Lexington Ave., New York, N. Y.

Automatic Controls

380. Pressure and liquid levels controls will maintain water level in 50-ft. tank within 1 foot. Send for full information. Electric Controller & Mfg. Co., 2710 East 79th St., Cleveland, O.

Cleaning Sewers

382. Low cost, rapid and complete cleaning of sewers. Booklet on request. Champion Corp., Hammond, Ind.

383. A 20-page booklet describes and illustrates a full line of sewer cleaning equipment—Rods, Root Cutters, Buckets, Nozzles and Flushers. Write W. H. Stewart (Pioneer, Mfr. since 1901), Jacksonville, Fla., or P. O. Box 767, Syracuse, N. Y.

Cast Iron Sewers

384. Cast Iron Pipe for Sewers. Cast Iron Pipe has beam strength, resistance to crushing stresses and infiltration-proof joints making it highly desirable for flow lines, force mains, submarine lines, outfalls and sewage treatment plants. For specifications write U. S. Pipe and Foundry Company, Burlington, N. J.

Chemical Treatment

385. A handbook on the application of chlorine and iron salts in sewerage treatment. Tech. Publication 177. Wallace & Tiernan Co., Inc., Newark, N. J.

Diesel Engines

386. Write Dept. 118, Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago, Ill., for data on how the installation of F-M diesels has lowered taxes and made it possible for many communitines to pay for their improvements out of municipal power plant earnings.

Feeders, Chlorine, Amonia and Chemical

387. For chlorinating water supplies, sewage plants, swimming pools and feeding practically any chemical used in sanitation treatment of water and sewage. Flow of water controls dosage of chemical; reagent feed is immediately adjustable. Starts and stops automatically. Literature from % Proportioneers, Inc.% 96 Codding St., Providence, R. I.

388. Chemical Feed Machines. Description, principles of operation; data on installation. E. W. Bacharach & Co., Rialto Building, Kansas City, Mo.

Filter Plant Controllers

389. "The Modern Filter Plant" and the uses of Simplex Controllers for operation are described in a handy, 16-page booklet. Charts, data, curves and tables. Simplex Valve and Meter Co., 68th and Upland Sts., Philadelphia, Pa.

Flow Meters

391. The primary devices for flow measurement—the orifice, the pilot tube, the venturi meter and others—and the application to them of the Simplex meter are described in a useful 24-page booklet (42A). Simplex Valve and Meter Co., 68th and Upland Sts., Philadelphia, Pa.

Garbage Incineration

392. Send for full information about the Decarie Suspended Basket-Grate Garbage Incinerator which solves the garbage disposal problem of any city economically and with a minimum of space. Nichols Engineering and Research Corp., 60 Wall Tower, New York, N. Y.

Leak Locators

395. "Geophone, the only water leak locator with a lifetime guarantee," is the title of a new descriptive bulletin issued by Globe Instrument Mfg. Co., 122 East 42 St., New York, N. Y.

Manhole Covers and Inlets

404. Street, sewer and water castings made of wear-resisting chilled iron in various styles, sizes and weights. Manhole covers, water meter covers, adjustable curb inlets, gutter, crossing plates, valve and lamphole covers, ventilators, etc. Described in catalog issued by South Bend Foundry Co., South Bend, Ind.

Pipe, Concrete

409. An excellent 16-page booklet describes manufacture and installation of reinforced concrete pipe for gravity and pressure lines for sewage and storm drainage. Lock Joint Pipe Co., Ampere, N. J.

Pipe Forms

411. Making concrete pipe on the job to give employment at home is the subject of a new booklet just issued by Quinn Wire and Iron Works, 1621 Twelfth St., Boone, Ia., manufacturers of "Heavy Duty" Pipe Forms. Sent promptly on request.

Pipe Joints, Sewer

415. How to make a perfect sewer pipe joint—tight, prevents roots entering sewer, keeps lengths perfectly aligned; can be laid with water in trench or pipe. General instructions issued by L. A. Weston, Adams, Mass.

Pumps and Well Water Systems

420. Installation views and sectional scenes on Layne Vertical Centrifugal and Vertical Turbine Pumps fully illustrated and including useful engineering data section. Layne Shutter Screens for Gravel Wall Wells. Write for descriptive booklets. Advertising Dept., Layne & Bowler, Inc., Box 186, Hollywood Station, Memphis, Tenn.

Pumping Engines

424. "When Power Is Down," gives recommendations of models for standby services for all power requirements. Sterling Engine Company, Buffalo, N. Y.

Run-off and Stream-Flow

426. Excellent booklet describes and illustrates the latest types of instruments for measuring run-off, both from small areas for storm sewer design, and from large areas for determining water shed yield. Sent promptly by Julien P. Friez & Sons, Baltimore, Md.

Rustproofing, Electric

427. No painting costs. Current from special electrodes removes all corrosion and prevents rusting. Informative literature on request. Electro Rustproofing Co., 38 N. Jefferson St., Dayton, Ohio.

Screens, Sewage

428. Be assured of uninterrupted, constant automatic removal of screenings. Folder 1587 tells how. Gives some of the outstanding advantages of "Straightline Bar Screens" (Vertical and Inclined types). Link-Belt Co., 307 N. Michigan Avenue, Chicago Ill.

Meter Setting and Testing

430. All about setting and testing equipment for Water Meters—a beautifully printed and illustrated 40 page booklet giving full details concerning Ford setting and testing apparatus for all climates. Ford Meter Box Co. Wabash, Ind.

Small Septic Tanks

438. Septic Disposal Systems, Waterless Toilets, Multiple Toilets for Camps and Resorts, and other products for providing safer sewage disposal for unsewered areas are described and illustrated in data sheets issued by San-Equip Inc., 700 Brighton Ave., Syracuse, N. Y.

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These helpful booklets are FREE. Write to the firm whose name is given, mentioning PUBLIC WORKS, or to this magazine.

(Continued from page 57)

Sludge Drying and Incineration

439. The five basic steps of: sludge preparation; flash drying; incineration; deodorization; and dust collection are explained in a new 24 page booklet, No. 6781 issued by The Dorr Company, 570 Lexington Ave., New York, N. Y., sales representatives for the C-E Raymond system of sludge drying and incineration.

440. Disposal of Municipal Refuse: Planning a disposal system; specifications. The production of refuse, weights, volume, characteristics. Fuel requirements for incineration. Also detailed outline of factors involved in preparation of plans and specifications. Morse-Boulger Destructor Co., 216P East 45th St., N. Y.

444. A new booklet "Essential Factors in the Design and Layout of Swimming Pool Systems," with data on filtration equipment, fittings, solution feeders, accessories, etc., is available from Everson Manufacturing Co., 213 West Huron St., Chicago, Ill.

445. Data and complete information on swimming pool filters and recirculation plants; also on water filters and filtration equipment. For data, prices, plans, etc., write Roberts Filter Mfg. Co., 640 Columbia Ave., Darby, Pa.

446. 40-page Manual on swimming pools. Includes swimming and pool layouts, specifications, etc., and details concerning Permutit Swimming Pool Equipment. Write The Permutit Co., Dept. G-4, 330 West 42 St., New York, N. Y.

447. "Painting Swimming Pools," an interesting booklet by Dr. A. F. Pistor, covers the subject thoroughly, discussing objectively the relative merits of the different types of coatings recommended for that purpose. Write Inertol Co., 401 Broadway, New York, N. Y.

Taste and Odor Control

448. How, when, and where activated carbon can and should be used to remove all kinds of tastes and odors from water supplies is told in a booklet issued by Industrial Chemical Sales Div., 230 Park Ave., New York, N. Y. 77 pages, tables, illustrations and usable data.

Treatment

450. "Safe Sanitation for a Nation," an interesting booklet containing thumbnail descriptions of the different pieces of P.F.T. equipment for sewage treatment. Includes photos of various installations and complete list of literature available from this company. Write Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago, Ill.

453. New booklet (No. 1642) on Link-Belt Circuline Collectors for Settling Tanks contains excellent pictures; drawings of installations, sanitary engineering data and design details. Link-Belt Company, 2045 W. Hunting Park Ave., Philadelphia.

460. This new 145 page illustrated chemical products book contains 55 pages of Tables, Factors and valuable Reference Data. Issued by General Chemical Co., 40 Rector St., New York, N. Y.

461. Ferrisul for Water and Sewage Treatment. Handy booklet describing Ferrisul and telling how it is used. Merrimac Chemical Div., Everett Station, Boston, Mass.

Valves and Hydrants

470. Complete booklet with much worthwhile water works data describes fully Ludlow hydrants and valves. Sent on request. Ludlow Valve Mfg. Co., Troy, N. Y.

Water Works Operating Practices

490. "Important Factors in Coagulation" is an excellent review with bibliography and outlines of latest work done in the field. Written by Burton W. Graham and sent free on request to Activated Alum Corp., Curtis Bay, Baltimore, Md.

For the Engineer's Library

Brief reviews of the latest books, booklets and catalogs for the public works engineer.

From Far Away:

"From the Far Corners of the Earth" is the title of an excellent book issued by Norton Co., Worcester, Mass. Beautifully illustrated, this booklet tells of the development and use of abrasives in industry. Sent on request.

Asphalt Pavements:

Three new publications are available without charge from the Asphalt Institute, 801 Second Ave., N. Y.: *Materials,* a review, analysis and forecast covering slow-curing, cut-back and emulsified asphalts and asphalt cements; also penetration asphalt tests and mineral aggregates. *Design and Construction,* analyses of asphaltic types, including relation of base to wearing surface, surface treatment, road-mix, penetration macadam, plant-mix and airport surfacing. *Equipment,* development for bituminous construction, earth moving, distributors, rollers, graders, mixing plants, spreaders and maintenance tools.

Low-Cost Airports:

How "low-cost airports" can be built anywhere is graphically told in a folder just issued by R. G. LeTourneau, Inc., Peoria, Ill. Covers initial land clearing, leveling, finish grading, maintenance and hangar erection. Sent on request.

Pipe Line Capacity:

A 4-page booklet dealing with carrying capacity tests made last summer on three Lock Joint pipe lines in Denver has been issued by Lock Joint Pipe Co., Ampere, N. J. These lines were laid in the period from 1921 to 1939, so that data are presented for lines 9 and 18 years old, and a new line. Sent on request.

Maintenance Paints:

This booklet, attractively prepared, presents much information for the engineer on the correct usage of various paints. Included in the booklet is the announcement of a new ready-mixed aluminum paint in an unusually brilliant chrome color. Sent on request by Edward E. Allen Mfg. Co., 334-336 N. Bell Ave., Chicago, Ill.

Draglines:

A bulletin on draglines has recently been issued by Bucyrus-Erie Company. On its 32 pages are described the mechanical and structural details of draglines in various sizes. Photographs are used to illustrate these details, and in addition quite a number of interesting views show draglines at work all over the world. If you are interested in dragline work, this magazine will have a copy mailed to you, or write to Bucyrus-Erie Company, South Milwaukee, Wisconsin, and ask for a copy of Bulletin No. DL-1.

Index to ADVERTISEMENTS

NOW COMMUNITIES CAN AFFORD TO REMOVE ALL ICE AND SNOW FROM WINTER STREETS AND ROADS WITH INTERNATIONAL'S ROCK SALT

ENORMOUS progress has been made in meeting the public demand for highways made safe from ice and snow in winter—but anyone who has studied the problem knows that there is no real safety until ice has been completely removed.

By older methods, attaining this ideal has been impossible—but today there are miles and miles of streets and highways kept bare of snow and ice all winter long, by improved and economical methods of using International's Retsof, Detroit and Avery brands of Rock Salt. These new, low cost methods have been developed by International's Engineering Department, working in close co-operation with practical road men.

International will share with you, the results of all its research and engineering studies, its broad experience in making winter pavements really safe. If you will write for the free folder, "Making Winter Pavements Really Safe," you will get a summary of the facts. Better still, ask to have an International engineer call, with no obligation, to give you all the facts and answer any questions you may care to ask.

COMPARISON OF MELTING CAPACITIES OF SODIUM CHLORIDE AND CALCIUM CHLORIDE

(LABORATORY TESTS)

POUNDS OF ICE MELTED PER POUND OF CHEMICAL
Maintenance Committee, Highway Research Board Vol. 13

Temperature Deg. F.	Sodium Chloride (Salt)	77-80 percent Flake Calcium Chloride
30°	46.3 lbs. of ice	31.1 lbs. of ice
25°	14.4 lbs. of ice	10.4 lbs. of ice
20°	8.6 lbs. of ice	6.8 lbs. of ice
15°	6.3 lbs. of ice	5.5 lbs. of ice
10°	4.9 lbs. of ice	4.8 lbs. of ice
5°	4.1 lbs. of ice	4.4 lbs. of ice
0°	3.7 lbs. of ice	4.0 lbs. of ice
—6.5°	3.2 lbs. of ice	3.7 lbs. of ice

The greater ice melting power of ROCK SALT
Advantage of Rock Salt in percentages as calculated by International Salt Co., Inc.

Rock Salt melts 48.9% more ice
Rock Salt melts 38.4% more ice
Rock Salt melts 26.4% more ice
Rock Salt melts 14.5% more ice
Rock Salt melts 2.0% more ice
— 6.8% Temperatures at these low levels are seldom long sustained, and make it impractical to use any ice melting
— 7.5% agent due to the large
—13.5% amount required

WHY INTERNATIONAL'S ROCK SALT IS SO ECONOMICAL WITH THIS METHOD

Because of its great melting power, Rock Salt is most economical for use in treating stock piles of abrasives to keep them from freezing, and in treating abrasives so that they will be imbedded in ice. For the same reason, Rock Salt used alone is the most economical melting agent to *remove* ice and hard-packed snow. A little does much. In addition, this method saves: cost of abrasives, cost of treating, storing, reloading and applying them; the cost of removing them from roads and streets, sewers and catch basins later; and, since proper use of straight Rock Salt corrects all effects of storms with one treatment, saves the cost of treatments several times a day for several days with abrasives. No wonder public officials say: "It costs less to keep pavements bare."

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Entered as second-class matter at the Post Office at New York, N. Y., Sept. 1, 1922, under the act of March 3, 1879.
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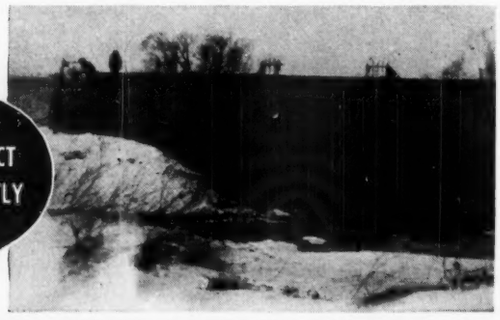
DECEMBER, 1939

Concreted at 2° Above



'INCOR' 24-HOUR CEMENT HALVES HEAT-PROTECTION COSTS ON WINTER WORK

SEVERE winter weather delayed construction of Route 30 highway bridge across Poultney River at Poultney, Vt. To get back on his schedule and at the same time reduce heating and overhead costs, Pascal C. Ricci, of Newport, N. H., Contractor, switched to 'Incor' 24-Hour Cement for the deck and sidewalks. And, take the word of Mr. Ricci, it paid him well!

Air temperatures, 2° above zero . . . concrete was placed in four continuous pours . . . heat protection supplied by salamanders. 'Incor' put the job back on schedule . . . cut heat-protection costs to the bone.

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Take advantage of these 'Incor' savings on work now in progress or about to start. Remember, by using 'Incor'* you'll be on the *safe* side . . . and on the *saving* side, too! Write for copy of "Cold-Weather Concreting." Lone Star Cement Corporation, Room 2203, 342 Madison Avenue, New York. *Reg. U.S. Pat. Off.

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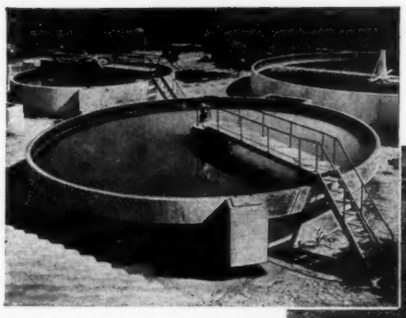
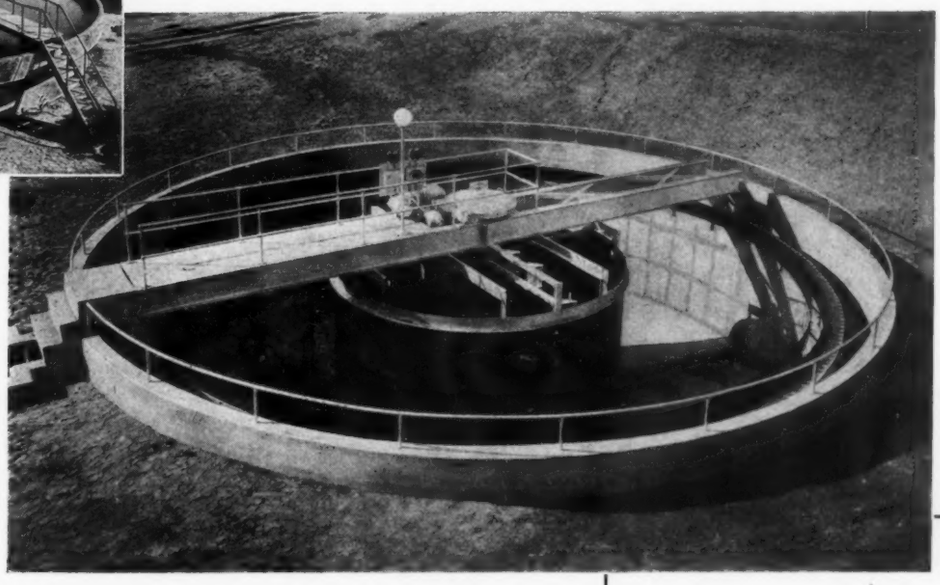


THE DORRCO CLARIFLOCCULATOR



Above: Dorrco Clariflocculator at Covina, Cal.

Right: Dorrco Clariflocculator at Ypsilanti, Mich.

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SUSPENDED SOLIDS REMOVALS IN RAW SEWAGE PREFLOCCULATION & SEDIMENTATION

Cedar Rapids, Iowa	75.5%
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San Francisco, Calif. Pilot Plant	70-75%
Ypsilanti, Michigan*	75.0%

*Dorrco Clariflocculator; at all others Dorrco Flocculator and Dorr Clarifier in separate tanks.

The Dorrco Clariflocculator gives these high removals on raw untreated sewage because the colloidal, finely-divided solids are built up mechanically into larger, more readily settleable flocs before being subjected to sedimentation.

In the inner, circular compartment—mechanical, preflocculation under controlled conditions. In the outer, annular compartment—quiescent sedimentation with mechanical removal of the settled solids and peripheral collection of the overflow.

No other process or method giving equivalent removals—70-80%—can compare with this on a first cost or operating cost basis. No other method assures, as does this one, that the fragile floc is transferred from the flocculation to the sedimentation unit intact—with its structure and settling quality unimpaired.

Check the removals in the table at the right. Compare them with the removals of around 55% generally obtained with primary sedimentation and the removals of about 85% that may be had with the far more costly treatment.

Remember, too, that if removals in excess of 70-80% should later be required these may easily be obtained in the same Dorrco Clariflocculator by the addition of chemicals.

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Highway improvements necessitated relocating a 36-inch, 46-year-old cast iron water main at Fort Worth, Texas. This pipe is shown above after being removed from the old trench.

At left is a close-up, unretouched photograph of a section of the relocated main shown here. Note fine condition of pipe interior.

Above is a photograph of the old pipe being relaid in a new location after 46 years of continuous service.

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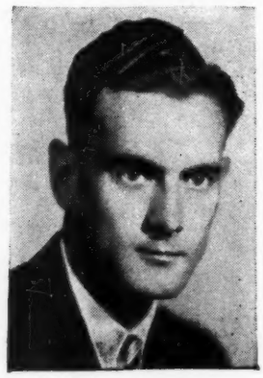

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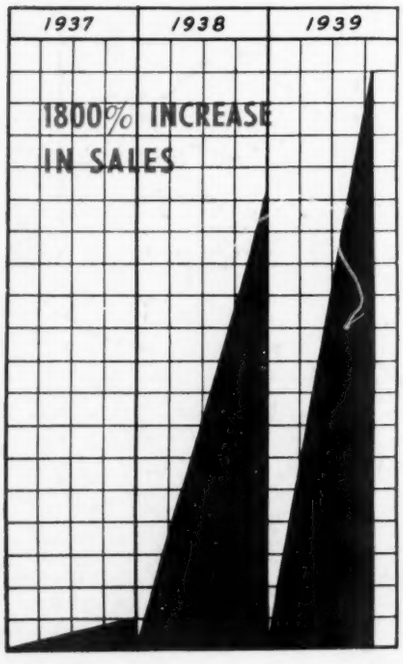

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